GeoScience Abstracts

3-667 TO 3-1029

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Vol. 3, No. 3

March 1961

published monthly by the
AMERICAN GEOLOGICAL INSTITUTE

GEOSCIENCE ABSTRACTS
published by the
American Geological Institute

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GeoScience Abstracts is published monthly, beginning with Volume 1, Number 1, January 1959, and replaces Geological Abstracts which was discontinued by the Geological Society of America at the end of 1958. The journal has received a grant in aid from the National Science Foundation to provide initial working funds.

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Volume 2, Number 12 is published in two parts, of which this is Part II.

GeoScience Abstracts

published monthly by the
AMERICAN GEOLOGICAL INSTITUTE

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World Construction. Chicago.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-750, 3-753 through 3-760; Structural Geology 3-789; Stratigraphy 3-794.

3-667. Hunting Survey Corporation Ltd., Calgary, Alberta. PHOTOGEOLOGICAL INTERPRETATION AND COMPILATION, EXSHAW-GOLDEN. Prepared for the A.A.P.G. Western Canada Regional Meeting and the A.S.P.G. Tenth Annual Field Conference. Geology by C. Wright-Broughton: Alberta Soc. Petroleum Geologists, Map no. 2, 2 sheets, scale 1 in. to 2 mi., secs., May 1960.

3-668. Riley, George C. GEOLOGY, FORT FITZGERALD, WEST OF FOURTH MERIDIAN, ALBERTA: Canada, Geol. Survey, Map 12-1960, scale 1:253,440, descriptive notes, 1960, 4 refs.

Preliminary series geological map of about 5,500 sq. mi., W. of Uranium City, E. of the Mackenzie Highway, along the junction of the Peace and Slave rivers. The oldest sediments are Precambrian and are relatively undeformed and unmetamorphosed. Sedimentary and metamorphic bands overlie quartzite, graywacke, arkose, and shale and are separated by areas of gneisses and granitic rocks. Porphyroblastic feldspar is found with various combinations of biotite chlorite, feldspar, and quartz in many of the Precambrian rocks. Certain areas of granitic rocks exhibit inherited fold structures. These granites are synkinematic and are cut by younger, late- or post-kinematic granite. Proterozoic (or later) purple sandstone with quartzite-pebble layers unconformably overlie the Precambrian metasediments. Devonian or earlier limestone, dolomite, evaporites, and sandstone compose the Devonian. Isoclinal folding is common in the metasediments, and many of the gneisses have been intensely deformed, with much evidence of plastic flow. Intense shearing along many of the faults has led to the development of augen and metacrystic gneiss.--M. Stewart.

3-669. Williams, H. GEOLOGY, CHISEL LAKE, MANITOBA: Canada, Geol. Survey, Map 27-1960, scale 1:12,000, descriptive notes, 1960, ref.

Large-scale geological map of an area NE. of Le Pas and directly E. of Flin Flon. The area is Precambrian and is structurally situated on the western limb of the Threehouse syncline. All rocks have been regionally metamorphosed. The oldest rocks, found in the Amisk group, comprise mainly basic volcanics. Quartz amygdules, pillow structure and massive amphibolites derived from flow rocks are abundant. Exceedingly garnetiferous amphibolite and related rocks are found to be derived from the Amisk volcanic rocks. "Quartz eye" granite gneiss is differentiated from other granitized derivatives of the Amisk group. To the W. of Chisel Lake is a lopolithic structure. In the individual rock types, recrystallization is due to metamorphism, but a sequence from metaperidotite to metadiorite is readily discernible. Faults are not abundant, but minor shears are common. A large base-metal ore body has been found hidden beneath the southern end of Chisel Lake. The main ore mineral is sphalerite, but pyrite, pyrrhotite, chalcopyrite, galena, and arsenopyrite are also present. Other minerals of lesser importance but of academic interest are tourmaline, gahnite, and apatite.--M. Stewart.

3-670. Stockwell, C.H. FLIN FLON-MANDY, MANITOBA AND SASKATCHEWAN: Canada, Geol. Survey, Map 1078A, scale 1:12,000, descriptive notes, 1960.

Large-scale geological map of Precambrian rocks on the northern boundary of Saskatchewan and Manitoba. The oldest rocks of the area consist of lava flows with pyroclastic breccias of the Archean Amisk group. Nonporphyritic andesite, basalt, dacite, and flow breccia are predominant. Possibly also closely related to the flows are dikes, sills, and irregular bodies of metadiorite and metagabbro. The Cliff Lake granite porphyry is characterized by abundant large eyes of bluish quartz. Missi conglomerate lies with angular unconformity on the Amisk group. Cross-bedding is characteristic of the 3 subdivisions in the Missi group. Diorite, granite, granodiorite, gabbro, plus boundary intrusions of a variety of rocks complete the sequence below the Kaminis granite, a porphyritic granite with phenocrysts of feldspar.

Structurally the rocks of the Amisk group were closely folded and deeply eroded before the Missi sediments were deposited; the Missi group itself was subsequently folded. Lineation and schistosity occur throughout much of the area but were not observed in the Kaminis granite nor in related porphyry dikes. Faults are numerous.

The area is important economically because it contains 3 base metal mines and smelter. Cu, Zn, Au, and Ag, with some Cd, Se, and Te have been recovered. The ore is associated with quartz porphyry between competent lava flows and sheared pyroclastic and flow breccias. Metallic minerals include pyrite, sphalerite, chalcopyrite, galena, tetrahedrite, arsenopyrite, magnetite, pyrrhotite, and Au.--M. Stewart.

3-671. Alcock, Frederick James. GEOLOGY, MUSQUASH, CHARLOTTE, KINGS, AND SAINT JOHN COUNTIES, NEW BRUNSWICK: Canada, Geol. Survey, Map 1084A, scale 1:63,360, descriptive notes, 1959.

Geological map of some 350 sq. mi., S. of Saint John. The oldest rocks of the area are Archean limestone, dolomite, quartzite, and argillite schist of the Green Head group. A Silurian or earlier(?) age is given to granite, diorite, and other basic or volcanic rocks. The older rocks along the granite contact are in places schistose, and even gneissose. Sediments of the Mississippian or Pennsylvanian Mispek group consist chiefly of sandstone with minor amounts of conglomerate and shale. Volcanic flows and tuffs associated with the sediments complete the series. The Carboniferous Lancaster formation is composed mainly of gray sandstones. At a number of places the formation has yielded a number of plant fragments. Coarse conglomerate and sandstone containing large well-rounded boulders compose the overlying Lepreau formation, the top of the Mesozoic. The rocks of the Lepreau formation are faulted. Investigation of possible coal beds and specular Fe in sediments has been without encouraging results.--M. Stewart.

3-672. MacKenzie, G.S., and Frederick James Alcock. GEOLOGY, ROLLING DAM, CHARLOTTE

COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Map 1097A, scale 1:63,360, descriptive notes, 1960.

Geological map of about 400 sq. mi., W. of St. John and SW. of Fredericton. Rocks are all of Paleozoic age. An assemblage of altered clastic sediments with minor amounts of volcanic rocks, all of the Charlotte group, are the oldest rocks of the area. These are classed as pre-Silurian, probably Ordovician. The Silurian, represented by the Mascarne group, has at its base the Oak bay conglomerate and some arkose. Plutonic rocks intrude the Silurian and the Charlotte group. The youngest consolidated formation is the Mississippian red conglomerate. The chief evidence of mineralization consists of quartz veins and schists carrying sulfides.--M. Stewart.

3-673. Perry, S.C., and Frederick James Alcock. GEOLOGY, ST. GEORGE, CHARLOTTE COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Map 1094A, scale 1:63,360, descriptive notes, 1960.

Geological map of about 300 sq.mi. on the Bay of Fundy coast, S. of Saint John. The oldest rocks of the area are Proterozoic (or earlier) volcanics and comprise both flow and fragmental types. These volcanic rocks are cut by many felsitic and granitic dikes, all of Silurian age. Sediments associated with the volcanic rocks comprise shale, sandstone, conglomerate, and limestone. Silurian rocks are intruded by plutonic rocks consisting of Middle Devonian gabbro, diorite, and biotite granite. Upper Devonian Perry formation consists of red conglomerate and sandstone, resting unconformably on the Silurian rocks. Pennsylvanian Lancaster sandstone, conglomerate, and shale completes the Paleozoic sequence. Conglomerate and sandstone of the Triassic Lepreau formation are the youngest rocks. Along the coast, the glacial striations and roches moutonnées are abundant. Dark gabbro is quarried as monumental stone; bornite and magnetite are the major mineral occurrences.--M. Stewart.

3-674. MacKenzie, G.S., and Frederick James Alcock. GEOLOGY, ST. STEPHEN, CHARLOTTE COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Map 1096A, scale 1:63,360, descriptive notes, 1960.

Geological map of about 300 sq. mi. along the coast of Passomaquoddy Bay, S. of Fredericton. The oldest rocks of the region are Ordovician or earlier altered clastic sediments, with minor amounts of interbedded volcanic rocks of the Charlotte group. These are considered to be pre-Silurian, probably Ordovician in age. The Silurian sediments, volcanic rocks, and the dark argillite of the Charlotte group are intruded by plutonic masses of Middle Devonian gabbro or peridotite. Devonian granite underlies wide areas. The youngest bedrock is that of the Upper Devonian Perry formation, consisting of red conglomerate, sandstone, and shale. It includes some interbedded lava flows and associated diabase dikes. The region has been heavily glaciated. Cu-Ni-bearing sulfides have been found in the map-area, and granite is quarried at 2 locations.--M. Stewart.

3-675. Smith, Charles H. GEOLOGY, TROUT RIVER, ISLAND OF NEWFOUNDLAND: Canada, Geol. Survey, Map 1086A, scale 1:63,360, descriptive notes, 1960, 3 refs.

Geological map of approximately 300 sq. mi. on the Gulf of St. Lawrence, about 150 mi. NE. of Corner Brook. The area contains Paleozoic and Cenozoic rocks. The oldest, the Middle Ordovician Humber Arm group, consists of shale, sandstone, and volcanic rocks, mostly basaltic andesites. Pillows and breccias are abundant. Ultrabasic and gabbroic intrusions have thermally metamorphosed the Humber Arm group. Ultrabasics and gabbroic intrusions compose much of the pre-Carboniferous Bay of Islands igneous complex. The North Arm Mountain pluton of primarily banded peridotite and dunite, is one of the most complete composite bodies in the complex. Quartz diorite intrusions cut the North Arm Mountain gabbros at many places. Small diabase dikes cut the gabbro and quartz diorite. Pleistocene alluvium completes the stratigraphic column. The area can be divided into at least 4 structural units that have moved upward to the NW. along NE.-trending, high-angle reverse faults. In the Bay of Islands complex, asbestos, chromite, Cu, nickel sulfides, and chalcopyrite-bearing quartz veins are found. The Stowbridge chromite deposit in the upper part of the North Arm Mountain ultrabasic zone consists of a series of small chromite lenses in dunite. Asbestos is also found in small ultrabasic layers.--M. Stewart.

3-676. Canada, Geological Survey, and Ontario, Dept. of Mines. BIG CANOE LAKE, COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1003, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 86°-86°30'W., 1960.

3-677. Canada, Geological Survey, and Ontario, Dept. of Mines. BRUCE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 861, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 93°-93°30'W., 1960.

3-678. Canada, Geological Survey, and Ontario, Dept. of Mines. DUSEY LAKE, THUNDER BAY AND COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 992, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 86°30'-87°W., 1960.

3-679. Canada, Geological Survey, and Ontario, Dept. of Mines. EBY FALLS, COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1002, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 86°-86°30'W., 1960.

3-680. Canada, Geological Survey, and Ontario, Dept. of Mines. FISHTRAP LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1007, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 86°-86°30'W., 1960.

3-681. Canada, Geological Survey, and Ontario, Dept. of Mines. GOLDPINES, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 860, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-

50°45'N., long. 93°-93°30'W., 1960.

3-682. Canada, Geological Survey, and Ontario, Dept. of Mines. GOODS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 998, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 86°30'-87°W., 1960.

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3-684. Canada, Geological Survey, and Ontario, Dept. of Mines. HARVEY LAKE, THUNDER BAY AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 982, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 87°-87°30'W., 1960.

3-685. Canada, Geological Survey, and Ontario, Dept. of Mines. HENFREY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 863, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 93°-93°30'W., 1960.

3-686. Canada, Geological Survey, and Ontario, Dept. of Mines. KAGIAMI FALLS, THUNDER BAY AND COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 993, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 86°30'-87°W., 1960.

3-687. Canada, Geological Survey, and Ontario, Dept. of Mines. KAPIKOTONGWA LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 980, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 87°-87°30'W., 1960.

3-688. Canada, Geological Survey, and Ontario, Dept. of Mines. KITCHIE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 997, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 86°30'-87°W., 1960.

3-689. Canada, Geological Survey, and Ontario, Dept. of Mines. LA ROSE LAKE, COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1001, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 86°-86°30'W., 1960.

3-690. Canada, Geological Survey, and Ontario, Dept. of Mines. LOUELLA FALLS, COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1000, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 86°-86°30'W., 1960.

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3-693. Canada, Geological Survey, and Ontario, Dept. of Mines. MARGOT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 867, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 93°-93°30'W., 1960.

3-694. Canada, Geological Survey, and Ontario, Dept. of Mines. MAXEY LAKE, KENORA, COCHRANE, AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 994, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 86°30'-87°W., 1960.

3-695. Canada, Geological Survey, and Ontario, Dept. of Mines. NECHIGONA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 865, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 93°-93°30'W., 1960.

3-696. Canada, Geological Survey, and Ontario, Dept. of Mines. NORTHWIND LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 869, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 93°-93°30'W., 1960.

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3-698. Canada, Geological Survey, and Ontario, Dept. of Mines. NOTTIK ISLAND, COCHRANE AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1004, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 86°-86°30'W., 1960.

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3-701. Canada, Geological Survey, and Ontario, Dept. of Mines. PATIENCE LAKE, THUNDER BAY AND COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 991, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 86°30'-87°W., 1960.

3-702. Canada, Geological Survey, and Ontario, Dept. of Mines. PERCY LAKE, THUNDER BAY AND COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 990, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 86°30'-87°W., 1960.

3-703. Canada, Geological Survey, and Ontario, Dept. of Mines. PRIME LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 999, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 86°30'-87°W., 1960.

3-704. Canada, Geological Survey, and Ontario, Dept. of Mines. PULHAM LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 988, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 87°-87°30'W., 1960.

3-705. Canada, Geological Survey, and Ontario, Dept. of Mines. PYM ISLAND, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1006, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 86°-86°30'W., 1960.

3-706. Canada, Geological Survey, and Ontario, Dept. of Mines. SAMPSON LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 866, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 93°-93°30'W., 1960.

3-707. Canada, Geological Survey, and Ontario, Dept. of Mines. SEBERT LAKE, KENORA AND COCHRANE DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1005, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 86°-86°30'W., 1960.

3-708. Canada, Geological Survey, and Ontario, Dept. of Mines. SHIBLEY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 996, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 86°30'-87°W., 1960.

3-709. Canada, Geological Survey, and Ontario, Dept. of Mines. SYMONS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 1008, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 86°-86°30'W., 1960.

3-710. Canada, Geological Survey, and Ontario, Dept. of Mines. TROUT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 862, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 93°-93°30'W., 1960.

3-711. Canada, Geological Survey, and Ontario, Dept. of Mines. WABASSI FALLS, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 995, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 86°30'-87°W., 1960.

3-712. Canada, Geological Survey, and Ontario, Dept. of Mines. WHITELOON LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 868, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 93°-93°30'W., 1960.

3-713. Canada, Geological Survey, and Ontario, Dept. of Mines. WINDFALL CREEKS, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 864, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 93°-93°30'W., 1960.

3-714. Canada, Geological Survey, and Ontario, Dept. of Mines. WINDSOR LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 986, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 87°-87°30'W., 1960.

3-715. Canada, Geological Survey, and Ontario, Dept. of Mines. WINISK LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 989, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 87°-87°30'W., 1960.

3-716. Tremblay, Leo-Paul. GEOLOGY, PHELPS LAKE, SASKATCHEWAN: Canada, Geol. Survey, Map 5-1960, scale 1:253,440, descriptive notes, 1960, 4 refs.

Preliminary series geological map of about 4,500 sq. mi. on the Manitoba-Saskatchewan border, E. of Uranium City. All rocks of this area are probably Archean in age. The succession of formations is based on the intensity of metamorphism and granitization. There is primarily a gray metasomatic granite, followed by a medium- to coarse-grained feldspar-biotite gneiss (probably derived from interbedded sedimentary rocks) and recrystallized impure carbonate rocks of the scarn type. This is followed by a moderately granitized fine- to medium-grained quartz-feldspar-biotite gneiss derived from interlayered sedimentary rocks. Massive- to well-bedded hornblende feldspar gneiss and schist, probably of sedimentary and tuffaceous origin make up the next unit. The final unit is mainly composed of argillite, graywacke, quartzite, and crystalline limestone. White to red pegmatites were seen almost everywhere. Black tourmaline, apatite, garnet epidote, mica, and some amphibole were recognized in some pegmatite dikes. Eastern part comprises part of the limb of a major anticline. Western part is closely folded into northeasterly trending anticlines and synclines. No major faults were recognized.--M. Stewart.

3-717. Acton, D.F., and others. PHYSIOGRAPHIC DIVISIONS OF SASKATCHEWAN: Saskatchewan Research Council, Geology Div., [Map 1], scale 1:1,520,640, 1960.

The physiographic divisions of Saskatchewan are shown on a colored map. An appended table contains a brief description of the topography, land forms, elevation, surficial and bedrock geology for each division. The map and table define 4 orders of physiographic units of Saskatchewan. The Interior Plains are divided into 3 provinces: Northern Plains province, Central Lowlands province, and Great Plains province. In turn, the Great Plains province is divided into Saskatchewan Plains and Alberta High Plains each of which is further subdivided into sections.--E.A. Christiansen.

3-718. Campbell, R.B., and John O. Wheeler. GEOLOGY, GLENLYON, YUKON TERRITORY: Canada, Geol. Survey, Map 25-1960, scale 1:253,440, descriptive notes, 1960.

Preliminary series geological map of about 400 sq. mi. between Whitehorse and Keno Hill. As only one unit, the Lower Mississippian limestone, yielded datable fossils, the column should be regarded only in a general way. Metamorphic rocks overlain by Proterozoic and/or Paleozoic quartzose and limy rocks are the oldest rocks of the area.

Cambrian(?) crystalline and phyllitic limestone, plus Cambrian(?) and/or Ordovician(?) shale and argillite, is followed by Silurian(?) and Devonian(?) quartzite and dolomite. Mississippian and (?)later rocks comprise clastics, metasedimentary, and sedimentary rocks. Serpentinite, followed by limestone and basaltic flows form the Mississippian or later sequence. Triassic limestones and volcanics, Jurassic arkose and conglomerate, form the Lewes River and Laberge groups respectively. Two small outcrops of conglomerate are believed to belong to Lower Jurassic(?) and Lower Cretaceous(?) Tantalous group. These are also granites of the same probable age. Fine-grained intrusions which cut Paleozoic rocks are classed as Tertiary. Pleistocene and Recent deposits complete the column. Some large through-going faults are inferred, but profound breaks in the geology provide reasonable assumption for their existence. Folds trend generally NW. The only important sulfide deposits observed in the area are Pb-Zn.--M. Stewart.

3-719. Petroleum Information Corp., Denver, Colorado. [OIL AND GAS FIELDS] MAP OF THE ROCKY MOUNTAIN REGION: scale 1 in. to 24 mi., Aug. 1960.

Map shows oil and gas fields, pipelines, granite areas, counties, townships, and ranges in Colorado, Wyoming, and parts of Montana, Idaho, Utah, Arizona, New Mexico, Kansas, Nebraska, North and South Dakota.

3-720. Schnabel, R.W. BEDROCK GEOLOGY OF THE AVON QUADRANGLE, CONNECTICUT: U.S. Geol. Survey, Geol. Quad. Map GQ-134, scale 1:24,000, contour interval 10 ft., lat. 41°45'-41°52'30"N., long. 72°45'-72°52'30"W., 1960.

The Avon quadrangle is in N.-central Connecticut. Bedrock consists of 3 basaltic lava flows interlayered with Triassic red beds of the Newark group. The lower part of the sedimentary sequence is intruded by a sill-like diabase body. A very small area in the NW. corner is probably underlain by pre-Triassic crystalline rocks. Because the area is covered by extensive deposits of glacial drift, individual bedrock exposures are shown on the map.--U.S. Geol. Survey.

3-721. Rose, William D. STRUCTURE MAP OF GREENVILLE QUADRANGLE, KENTUCKY: Kentucky Geol. Survey, Ser. 10, [Map], scale 1:24,000, July 1960.

This map was prepared to show the present oil and gas development in the area and its relation to structure and for use as a tool in further exploration. Subsurface structure on the base of the Vienna limestone (upper Chester, Mississippian) is shown by 20-ft.-interval contours; faults are plotted at the Vienna level.

Oil and gas pools are outlined and named; wells are plotted and type indicated by symbol. A lithological well log of the R.W. Southard No. 1 (3) J. Corley is presented to serve as a general stratigraphic section for the area.--T.J. Crawford.

3-722. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN BOONE, CAMPBELL, GRANT, KENTON, AND PENDLETON COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-15, 3 sheets, scale 1:125,000, lat. 38°30'-39°05'N., long. 84°15'-84°50'W., 1960.

These atlases (HA-15 to HA-25, see citations below) show the geology and availability of ground water in the Blue Grass region, Kentucky. Each atlas contains 3 sheets. Sheet 1 shows the geology, sheet 2 shows the water availability, and sheet 3 is a generalized columnar section of the area.

3-723. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN BRACKEN, HARRISON, MASON, NICHOLAS, AND ROBERTSON COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-16, 3 sheets, scale 1:125,000, lat. 38°15'-38°50'N., long. 83°40'-84°30'W., 1960.

3-724. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN LEWIS AND ROWAN COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-17, 3 sheets, scale 1:125,000, lat. 38°05'-38°40'N., long. 83°05'-83°40'W., 1960.

3-725. Hall, Francis R., and W.N. Palmquist, Jr. AVAILABILITY OF GROUND WATER IN BATH, FLEMING, AND MONTGOMERY COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-18, 3 sheets, scale 1:125,000, lat. 37°55'-38°30'N., long. 83°30'-84°05'W., 1960.

3-726. Hall, Francis R., and W.N. Palmquist, Jr. AVAILABILITY OF GROUND WATER IN CLARK, ESTILL, MADISON, AND POWELL COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-19, 3 sheets, scale 1:125,000, lat. 37°35'-38°05'N., long. 83°40'-84°30'W., 1960.

3-727. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN BOYLE, GARRARD, LINCOLN, AND MERCER COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-20, 3 sheets, scale 1:125,000, lat. 37°15'-38°N., long. 84°20'-85°W., 1960.

3-728. Hall, Francis R., and W.N. Palmquist, Jr. AVAILABILITY OF GROUND WATER IN MARION, NELSON, AND WASHINGTON COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-21, 3 sheets, scale 1:125,000, lat. 37°25'-37°55'N., long. 85°05'-85°40'W., 1960.

3-729. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN BULLITT, JEFFERSON, AND OLDHAM COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-22, 3 sheets, scale 1:125,000, lat. 37°50'-38°30'N., long. 85°20'-85°55'W., 1960.

3-730. Hall, Francis R., and W.N. Palmquist, Jr. AVAILABILITY OF GROUND WATER IN CARROLL, GALLATIN, HENRY, OWEN, AND TRIMBLE COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-23, 3 sheets, scale 1:125,000, lat. 38°25'-38°50'N., long. 84°35'-85°25'W., 1960.

3-731. Hall, Francis R., and W.N. Palmquist, Jr. AVAILABILITY OF GROUND WATER IN ANDERSON, FRANKLIN, SHELBY, SPENCER, AND WOODFORD COUNTIES: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-24, 3 sheets, scale 1:125,000, lat. 37°55'-38°20'N., long. 84°40'-85°30'W., 1960.

3-732. Palmquist, W.N., Jr., and Francis R. Hall. AVAILABILITY OF GROUND WATER IN BOURBON, FAYETTE, JESSAMINE, AND SCOTT COUNTIES, KENTUCKY: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-25, 3 sheets, scale 1:125,000, lat. 37°45'-38°25'N., long. 84°-84°40'W., 1960.

3-733. Kottlowski, Frank E. RECONNAISSANCE GEOLOGIC MAP OF LAS CRUCES THIRTY-MINUTE QUADRANGLE: New Mexico, Bur. Mines and Mineral Resources, Geol. Map 14, col. map, scale 1:126,720, 2 secs., 1960, 6 refs.

The quadrangle, covering about 1,012 sq. mi., is in S.-central New Mexico, straddles the Mesilla Valley of the Rio Grande, and encompasses physiographic and structural features typical of the Mexican Highlands section of the Basin and Range province, as shown in the northern Franklin Mountains, Organ, Robledo, and Dona Ana Mountains, and southern San Andres Mountains, as well as the southern Jornada del Muerto and eastern La Mesa plains.

The Precambrian rocks are overlain by a northward thinning sequence of lower Paleozoic formations, Cambrian to Mississippian in age. Pennsylvanian strata thicken eastward from 665 ft. (Robledo Mountains) to 2,800 ft. (San Andres Mountains), with the Permian represented by the Bursum, Abo red-bed tongue, and Hueco formations.

Basal Tertiary rocks are the Love Ranch formation in the Organ and San Andres Mountains and interbedded gypsum and latitic tuffs in the Robledo Mountains. Above is a sequence of andesite-latite volcanic rocks, which is overlain unconformably by 2 groups of rhyolitic rocks. The older rhyolite group includes the Soledad rhyolite in the Organ Mountains and similar rocks in the Dona Ana Mountains that were intruded by the Organ Mountains monzonite batholith and correlative dikes and sills. The younger rhyolitic group, the Bell Top formation, and associated domes, dikes, and sills, unconformably overlies all the older volcanic rocks.

The Pliocene-Pleistocene Santa Fe group was mapped as a lower sequence of sandstones, conglomerates, siltstones, impure limestones, and the Selden basalt flow, conformably overlain by an upper sequence of relatively unconsolidated sand and gravel. Large parts of the high plains bordering the Mesilla Valley are underlain by calichified gravel and silt cut by the La Mesa surface W. of the Rio Grande and the Jornada surface to the E. Lower terrace gravels underlie the several Picacho terrace levels along the valley wall. Relatively unweathered basalt flows, representing at least 3 periods of eruptions, cap some of the terraces and occur on La Mesa.

The major mines of the Organ mining district (Cu, Pb, Zn) are shown, as well as scattered fluorite mines, and gypsum, riprap, and sand and gravel quarries. Major faults in the San Andres-Organ-Franklin Mountains chain of ranges are roughly N.-S., whereas those in the Robledo Mountains-La Mesa area curve southward from NW.-trending to NE.-SW.--Auth.

3-734. Elston, Wolfgang E. RECONNAISSANCE GEOLOGIC MAP OF VIRDEN THIRTY-MINUTE QUADRANGLE: New Mexico, Bur. Mines and Mineral Resources, Geol. Map 15, scale 1:126,720, 1960, 5 refs.

The quadrangle, covering about 1,105 sq. mi., is in southwestern New Mexico and contains structural and physiographic features typical of the Mexican Highlands section of the Basin and Range province. The Gila River crosses the mapped area from N. to W.

Unconformably above the Precambrian granite and metamorphic rocks is the Cretaceous Beartooth quartzite and overlying Colorado shale. Near the Steeple Rock mining district, the Colorado shale at one locality is overlain by the Virden formation, but at another locality the Virden formation is underlain, in descending order, by andesite, rhyolite, and dacite volcanic rocks. The Virden formation contains plant fossils tentatively dated as late Cretaceous in age. Late Cretaceous and early Tertiary intrusive bodies are of andesite, monzonite porphyry, and rhyolite.

The Datil formation, of rhyolite volcanic rocks and some andesite and latite porphyry, rests on rocks ranging from the Virden formation down to the Precambrian and is overlain, in ascending order, by a local latite, widespread basalt and basaltic andesite, and a local perlitic rhyolite. These volcanic rocks are overlain by the Gila conglomerate. Terrace gravels crop out along the Gila River and on the edges of dissected bolsons.

The scattered mines and large prospects are shown, including those of the Black Hawk (Ag) and Steeple Rock (Au-Ag-Cu-Pb-Zn) districts. Major faults trend NW.-SE. throughout the mapped area.--F.E. Kottlowski.

3-735. Ohio, Division of Geological Survey. OIL AND GAS FIELDS OF OHIO: Its: [Map], scale 1 in. to 6 mi., sec., 1960.

This map in 3 colors shows the extent of known oil fields, gas fields, and underground storage areas for natural gas and liquid fuels. Listed are the names of the oil and gas fields, producing horizons, depths to producing horizons, and discovery dates of the fields. A generalized stratigraphic column for Ohio gives geologic names and driller's terms.--P. Smyth.

3-736. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE. SHEET A - 83°30' TO 83°00' WEST LONGITUDE: Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 6 maps, secs., diags., profiles, graphs text, 1960, approx. 25 refs.

First of a series of 7 maps (remaining 6 in process of publication) giving information on shoreline and offshore deposits and a description of shore types. The area of shoreline shown is from near the Ohio-Michigan state line to near Port Clinton, Ohio. Five figures give detailed information concerning generalized cross sections of the area, borings and core sections, profiles of the shore and bottom. The coverage of the area by survey points, surveys of the U.S. Army, Corps of Engineers, aerial photographs and topographic quadrangles of the U.S. Geological Survey are given. Eight general figures show the location, wind data, wave energy data, physiography, geology, soils, and lake levels for Lake Erie. A text gives more detailed notes on bedrock (middle and upper Silurian dolomites and limestones) underlying the area, features and surficial deposits landward of the shoreline, shoreline features and deposits, nearshore features and bottom deposits, littoral drift, inferred sources of beach building materials, hydrology, lake levels, and ice. --J.R. Hyland.

3-737. Weir, Gordon W., and others. PRELIMINARY GEOLOGIC MAP AND SECTION OF THE MOUNT PEALE 2 SE QUADRANGLE, SAN JUAN COUNTY, UTAH: U.S. Geol. Survey, Mineral Inv. Map MF-143, scale 1:24,000, lat. 38°15'-38°22'30"N., long. 109°15'-109°22'30"W., 1960.

3-738. Robeck, Raymond C. MAP 1. SUBSURFACE STRUCTURE MAP, LISBON VALLEY ANTICLINE, UTAH: scale 1:55,600, contour interval 500 ft., The Author, 535 Orchard Ave., Grand Junction, Colorado, Dec. 1960.

This map is the first of 3 (see abstracts immediately below) on the Lisbon Valley anticline. The base map was compiled from U.S. Geological Survey photogeologic maps and covers the area T.30 S., R.'s 24 and 25 E. and 2 mi. of adjacent townships. The following data are given: 1) 500-ft. structure contours drawn on the top of the Mississippian; 2) surface formation contacts, major faults, axes, mines, dips and strikes, section land net, highways, roads, trails, and main washes; 3) all tests for oil and gas, giving discovery classification of oil, gas, or dry hole, with name of operator and numbers of wells, elevations on top of Mississippian.

Published separately is a Correlation Chart of all oil wells on Lisbon Valley anticline. The tops of all formations are plotted on vertical cross section at a scale of 1 in. to 500 ft. The chart shows producing oil and gas horizons, elevation, total depth.

Table 1, also published as a separate sheet, contains data on all wells on the Lisbon Valley anticline. It shows the following items: map number of wells, operator and farm name and number, location, elevation, total depth, producing zones, tops of formations as released by operators - Chinle, Moss Back, Moenkopi, Cutler, Hermosa, Paradox A, B, top of salt, base of salt, Molas, Mississippian, Ouray, Elbert, McCracken, and Cambrian.--From auth.

3-739. Robeck, Raymond C. MAP 2. SURFACE STRUCTURE MAP, LISBON VALLEY ANTICLINE, UTAH: scale 1:55,600, contour interval 100 ft., The Author, 535 Orchard Ave., Grand Junction, Colorado, Dec. 1960.

The second in a series of 3 maps on the Lisbon Valley anticline. The base map is identical to Map 1 (see above). Map 2 shows 100-ft. structure contours on top of the Chinle formation (Triassic). It is necessary to see both maps to see the discontinuity between the surface and Mississippian structures.--From auth.

3-740. Robeck, Raymond C. MAP 3. PHOTOGEOLOGIC MAP OF THE LISBON VALLEY ANTICLINE AND SURROUNDING AREA, SAN JUAN COUNTY, UTAH: scale 1:55,600, The Author, 535 Orchard Ave., Grand Junction, Colorado, [1960].

The third in a series of 3 maps on the Lisbon Valley anticline. It is a composite on 1 sheet of several U.S. Geological Survey maps and is the same base as is used for Maps 1 and 2 (see above). The map does not show oil and gas activities, but may be used as a base map for plotting interpretation of the Lisbon oil activity.--From auth.

3-741. U.S. Geological Survey. MT. RAINIER NATIONAL PARK, WASHINGTON: scale 1:62,500, contour interval 100 ft., lat. 46°44'-47°N., long. 121°30'-121°55'W., 1910, revised 1955, reprinted 1960.

3-742. Kish, George. ECONOMIC ATLAS OF THE SOVIET UNION: 96 p., maps, Ann Arbor, Michigan, University of Michigan Press, 1960, 75 refs.

Contained in this volume is a series of cartographic portraits of the Soviet economy, showing the present status of agriculture, mining, industry, transportation, and urbanization. This series was made possible by the increasing amount of primary resource material now available on the Soviet economy. The maps contained in this volume are organized in 2 groups: 5 general maps of the Soviet Union as a whole, and 60 regional maps of the 15 major economic regions. The general maps show physical features, vegetation zones, administrative divisions, air transportation, and population distribution. Each of the 15 economic regions is represented by a set of 4 maps. The first map deals with agriculture. The second is devoted to minerals, showing major deposits now exploited, oil and gas pipelines, and oil refineries. U is not shown because of a lack of official Soviet information. The third map illustrates industrial location, and the fourth map shows transportation and cities.

The 15 regions are: Central, Northwestern, North European, Western, Southern, Volga, North Caucasus, Trans-Caucasus, Ural, West Siberian, East Siberian, Far Eastern, North Siberian and Northeastern, Southern Central Asia, and Kazakhstan-Northern Central Asia.--L.M. Dane.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Engineering Geology 3-1010.

3-743. Edmonton Geological Society. **1960 FIELD TRIP GUIDE BOOK. ROCK LAKE: 98 p., illus., maps, charts, secs., Edmonton, Alberta, Aug. 1960.**

Edited by R.H.J. Elliott, this second guidebook of the Society contains an introductory historical article, 7 geologic papers on aspects of the transition area between the central Alberta foothills and northern Alberta foothills provinces by various authors (listed below), plus 3 road logs (Edmonton-Hinton; Hinton-Rock Lake; Hinton-Miette Hot Springs) by W. H. Ziegler. Papers titled in capitals are abstracted separately below.--R.S. Taylor.

MacGregor, J.G. The Athabasca-Smoky country, p. 1-10.
Charlesworth, H.A.K., and Remington, D.B. PRECAMBRIAN ROCKS IN THE VICINITY OF JASPER, ALBERTA, p. 11-18.
Orr, R.D. THE UPPER DEVONIAN JASPER BASIN, p. 19-23.
Manko, E.M. THE TRIASSIC OF THE ROCK LAKE AREA, p. 24-42.
Ziegler, W.H., and Pocock, S.A.J. THE MINNES FORMATION, p. 43-71.
Pearson, G.R. LOWER CRETACEOUS COAL DEPOSITS IN THE FOOTHILLS BETWEEN SHEEP CREEK AND WILDHAY RIVER, ALBERTA, p. 72-78.
Fox, F.G. Wildhay structure, p. 79-81.
Dahlstrom, C.D.A. CONCENTRIC FOLDING, p. 82-84.

3-744. **Charlesworth, H.A.K., and D.B. Remington. PRECAMBRIAN ROCKS IN THE VICINITY OF JASPER, ALBERTA (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 11-18, illus., geol. map, Edmonton, Alberta, 1960) 9 refs.**

A brief account is given of the stratigraphy and structure of the Precambrian rocks outcropping over an area of 30 sq. mi. around Jasper. In ascending order the Precambrian strata, all of shallow-water origin, have been divided into the Old Fort Point, Miette, and Jasper formations. The Old Fort Point formation consists mainly of greenish gray phyllites with interbedded edgewise conglomerates, carbonate, and siltstones. Interbedded conglomeratic sandstones and phyllites of deltaic origin make up the Miette formation, while the Jasper formation is composed almost entirely of arenaceous rocks overlain by carbonates, some of which contain abundant algaloid structures.

During the Laramide orogeny, the Precambrian beds underwent severe structural deformation accompanied by low-grade metamorphism and the emplacement of numerous veins. The strata, which are in fault contact with the Paleozoics of the eastern ranges, have been folded into a complex, northwesterly plunging anticlinorium. This structure is made up of a large number of minor folds with steep southwesterly dipping axial planes and steep to overturned dips. Metamorphism has converted the argillaceous sediments into phyllites, while in the sandstones albitization of the original feldspars has occurred. The veins are composed mainly of quartz, calcite, chlorite, siderite, and albite.--H.A.K. Charlesworth.

3-745. **Orr, Robert D. THE UPPER DEVONIAN JASPER BASIN (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 19-23, map, 2 diags., Edmonton, Alberta, 1960) 11 refs.**

Devonian sediments in the Jasper area of Alberta are divisible into a uniform upper (Palliser) and a variable lower (Alexo-Fairholme) unit. Two distinct biostratigraphic provinces, "reef" and "off reef," are evident within the Fairholme group. Four facies, the Flume, Perdrix, lower Mount Hawk, and upper Mount Hawk comprise the Fairholme of the Jasper "off reef" province. This pronounced "off reef" shale basin received silts and sands from a western source in upper Mount Hawk and Alexo time. The resulting clastic facies of the upper Mount Hawk contains an "Alexo type" faunal assemblage.--Auth.

3-746. **Manko, E.M. THE TRIASSIC OF THE ROCK LAKE AREA (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 24-42, illus., diag., secs., Edmonton, Alberta, 1960) 15 refs.**

The Triassic of the Rock Lake area is divided into the Whitehorse formation and the Sulphur Mountain formation. The Whitehorse is subdivided into a lower Evaporitic member, which includes the evaporitic facies and part or all of the dolomite-sandstone facies established by Best in the N. Saskatchewan-Athabasca Rivers area to the S., and an overlying Carbonate member. A new unit, the Red Bed member, is introduced in the upper Whitehorse of the Front Ranges. The Sulphur Mountain formation is subdivided into 4 distinct correlatable units, the Lower Black Siltstone unit, the Blocky Brown Siltstone unit, the Black Shale unit, and the Upper Siltstone unit, which are traceable into the Peace River region to the N. and into the Cadomin area to the SE. The Beyrichites-Gymnotoceras and Phosphate zones are cited as markers for correlation into the Peace River subsurface. A stratigraphic correlation chart is presented, illustrating the lithology, thickness and stratigraphic relationships of the Whitehorse and Sulphur Mountain formations and their units from the foothills edge across strike to immediately below the main ranges, the western limits of Triassic exposure.--Auth.

3-747. **Ziegler, W.H., and Stanley A.J. Pocock. THE MINNES FORMATION (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 43-71, illus., chart, diags., secs., Edmonton, Alberta) 46 refs.**

A Jurassic and Cretaceous sequence of strata between the Fernie formation (below) and the Cadomin formation (above) is described from the area N. of the Athabasca River. This sequence is predominantly composed of clastic sediments. A marine and a brackish-continental, coal-bearing facies development has been recognized. These facies differences have been largely responsible for the original distinction of 2 formations in this interval, i.e., the Kootenay formation (continental, etc.) and the Nikanassin formation (marine). These 2 facies developments, however, occur in practically all sections of this interval, in varying proportions. To prevent any further ambiguities in the use of these names, it is proposed to rename the entire sequence the Minnes formation and to reduce the former formation names to designate the 2 facies developments, e.g., continental Kootenay facies, marine Nikanassin facies. A type section for the formation at Mt. Minnes (British Columbia) is described. Facies studies show that the sediments were deposited in very shallow marine to swampy and continental environment.

Paleontological studies permit one to assign an Oxfordian age to the oldest strata of the type section. The Jurassic-Cretaceous boundary can also be recognized paleontologically. The upper part of the section is of Barremian age. The top of the formation is marked by a minor unconformity, below the Cadomin formation, whereas the basal contact to the Fernie is indistinct and is suspected to be diachronous.--Auth.

3-748. Pearson, G. Raymond. LOWER CRETACEOUS COAL DEPOSITS IN THE FOOTHILLS BETWEEN SHEEP CREEK AND WILDHAY RIVER, ALBERTA (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 72-78, map, Edmonton, Alberta, 1960) 12 refs.

Coal exploration was intermittently carried out in the foothills of Alberta N. of Athabaska River between 1909 and 1930. Renewed activity at the present time is due to the discovery of high-grade coking coals along Smoky River. The coal-bearing Luscar formation of early Cretaceous age outcrops in several northwesterly trending zones within the foothills subprovince of the Rocky Mountains. Four coal seams, between 5 and 12 ft. in thickness, have been found to have good coking properties. The coal is of low-volatile bituminous rank and reserves total several billion tons.--Auth.

3-749. Dahlstrom, C.D.A. CONCENTRIC FOLDING (In: Edmonton Geological Society. 1960 Field Trip Guide Book...: p. 82-84, 8 illus., fig., Edmonton, Alberta, 1960)

Simple concentric folds are present in the Mesozoic and Paleozoic rocks of the foothills and mountains, central Alberta. Selected examples are illustrated with oblique aerial photographs, and their characteristics are briefly compared with the ideal case.--Auth.

3-750. Carrigy, M.A. GEOLOGY OF THE McMURRAY FORMATION. PART III. GENERAL GEOLOGY OF THE McMURRAY AREA: Research Council Alberta, Geol. Div., Mem. 1, 130 p., 8 illus., 8 maps (Map 26, scale 1 in. to 4 mi., in pocket), 3 secs., graph, 12 tables, 1959, 136 refs.

This report forms the third part of a series on the geology of the McMurray formation (Cretaceous). The first 2 parts were published as Research Council of Alberta, Report 72, and were entitled, "Foraminifera of the Upper McMurray and Basal Clearwater Formations," and "Heavy Minerals of the McMurray Formation."--From foreword.

The McMurray area covers 7,000 sq. mi. of northeastern Alberta between lat. 56°30'-58°N., and long. 110°-112°E. The greater part of the area is a muskeg-covered plain at an elevation of 1,000 to 1,500 ft. above sea level. Standing about 1,000 ft. above this plain are isolated residual hills of the High Plains of Alberta, and incised into the plain to a depth of 200 ft. are the valleys of the northerly-flowing Athabasca River system. Precambrian rocks outcrop in the northeastern corner of the area as low rounded hills. Outcrops of Mesozoic and Paleozoic strata are confined to the river valleys.

The Paleozoic strata dip to the SW. at 30 ft. to the mile reaching a maximum thickness of 2,500 ft. These strata have been divided into 11 formations which have been correlated with Devonian sections in northern Saskatchewan and central Alberta. Post-Devonian movement in the Paleozoic strata has been attributed to normal faulting of the basement. Domes and basins observed in the Beaverhill Lake strata were probably caused by solution in the underlying Elk Point evaporites.

The Cretaceous strata form a homocline dipping to the SW. at less than 5 ft. to the mile, with local basinal flexures caused by collapse of the underlying limestones. The basal Cretaceous sands have been impregnated with heavy black oil and are known variously as the Athabasca tar sands, Athabasca bituminous sands, and the Athabasca oil sands. The quantity of oil present in these sands has been estimated to exceed 300 billion barrels.

Other unexploited industrial minerals in the McMurray area include salt, gypsum, limestone, dolomite, and silica sand.--Auth.

3-751. Belyea, Helen R. THE STORY OF THE MOUNTAINS IN BANFF NATIONAL PARK: 42 p., 36 illus., sec., 4 diags., table, Ottawa, Geological Survey of Canada, 1960, 6 refs.

A geological description and guide of the mountains in Banff National Park, Alberta, Canada. Sections are included on the rocks, building of the mountains, mountain sculpture, drainage patterns, and a glossary of terms. Some of the local points of geological interest discussed are: East Park entrance to Banff townsite, around Banff townsite, Banff to Eisenhower viewpoint, Eisenhower Junction to Kicking Horse Pass, Lake Louise area, and Banff-Jasper Highway.

3-752. Fyles, James T. GEOLOGICAL RECONNAISSANCE OF THE COLUMBIA RIVER BETWEEN BLUEWATER CREEK AND MICA CREEK (In: British Columbia, Dept. of Mines. Annual Report...1959: p. 90-105, 2 illus., geol. map, secs., 1960) 10 refs.

The Columbia River flows northwestward along the Rocky Mountain Trench to the Big Bend, where the direction of flow changes abruptly. Reconnaissance along a 115-mi. stretch was made to provide background for engineering geology problems in connection with possible dam construction.

In the Rocky Mountains, quartzite, argillite, and limestone are openly folded, and close to the Trench the folds are overturned to the SW. and are truncated by the Trench. In the Cummins Range to the N., overturning is to the NE., and the folds and associated thrust faults are parallel to the Trench. Metamorphism near the Trench is of high grade. In the Selkirk Mountains sedimentary rocks of moderate to high grade are closely folded in a manner that largely escapes detection except through detailed work.

SE. of the Bush River the White River break, marked by a broad shear zone, follows the Trench. NW. of the Bush River the Trench fault zone represents a continuation of the White River break and probably other regional faults. The dip is to the W., and some faulting apparently preceded metamorphism. --M.S. Hedley.

3-753. Liberty, B.A. RICE LAKE-PORT HOPE AND TRENTON MAP-AREAS, ONTARIO: Canada, Geol. Survey, Paper 60-14, 4 p., Maps 16-1960 and 17-1960 (in pocket), 1960, 12 refs.

Much of the area is occupied by glacial deposits, including part of the Oak Ridge interlobate moraine. Outcrop consequently is sparse except along the N. shore of Lake Ontario and in the Trent River area. Outcrops are of Middle Ordovician age, belong to the Trentonian stage, and reach a total thickness of about 600 ft. The 2 map units are designated as Sherman Fall beds and Coburg beds, to conform with nomenclature used by the writer in published reports dealing with areas to the W. and N.--P. Harker.

3-754. Benoit, F.W. PRELIMINARY REPORT ON CHOMEDEY-PAQUET AREA, ROBERVAL ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 426, 7 p., fold. geol. map (Prelim. Map no. 1336), scale 1:63,360, table, 1960, 3 refs.

The map-area (48°45'-49°N. 72°45'-73°15'W.), covering 400 sq. mi., was mapped in 1958 and 1959. Outcrops are continuous along both shores of Chamouchouane river and along part of the railroad. They are less numerous elsewhere, and are absent in that part of the area covered by drift.

All consolidated rocks are Precambrian, and are considered to belong in the Grenville subprovince. Granitic gneisses and hornblende-biotite paragneisses, thoroughly injected by pink granitic material in places, form the bulk of the bedrock in the area. Beds of crystalline limestone, quartzite, and garnetiferous paragneisses, as well as some small masses of metagabbro, are intercalated with the hornblende-biotite paragneisses. Charnockitic rocks, porphyritic or gneissic, have invaded the gneisses in the eastern part of the area. Small masses of granite are found here and there in the western part. Pegmatite is abundant along fault zones.--From auth., p. 2.

3-755. Brett, P. Robin. PRELIMINARY REPORT ON THE SOUTHEAST QUARTER OF LAMOTTE TOWNSHIP AND THE SOUTHWEST QUARTER OF LACORNE TOWNSHIP, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 428, 12 p., 2 fold. geol. maps (Prelim. Maps no. 1338, 1339), scale 1:12,000, table, 1960.

The map-area (48°17'-48°21'N. 78°14'-78°28'W.), mapped in 1959, covers 50 sq. mi. in western Quebec. All rocks are Precambrian. The 2 quarter townships are markedly different in their geology. The underlying formations of SW. Lacorne consist largely of hornblende biotite or muscovite granodiorite, which makes up part of the Lacorne batholith. A N.-S.-trending band of biotite schist and metamorphosed volcanic rocks crops out on the western side of the quarter township.

The rocks of SE. LaMotte are a complex of peridotite, pyroxenite, hornblendite, diorite, syenite, and biotite granodiorite. The same band of biotite schist and metamorphosed volcanic rocks mentioned above crops out in the eastern part of the quarter township. NE.-striking gabbro dikes cut across all the other rocks.--From auth., p. 1, 2.

3-756. Gaucher, Edwin H. PRELIMINARY REPORT ON THE SOUTHEAST QUARTER OF BARLOW TOWNSHIP, ELECTORAL DISTRICT OF ABITIBI-EAST: Quebec, Dept. Mines, Prelim. Rept. no. 425, 13 p., fold. geol. map, (Prelim. Map no. 1333), scale 1:12,000, table, 1960, 2 refs.

This part of Barlow township, covering 25 sq. mi., lies about 3 mi. W. of Chibougamau at 49°52'30"-49°57'30"N. 74°28'-74°35'W. It was mapped in 1958. All rocks are Precambrian. The oldest are Keewatin-type volcanic rocks, which are altered to greenstones. The greenstones represent metabasalts and metaandesites, many of which are carbonated and associated with a few tuff beds. Feldspathic pyroclastic rocks, banded tuffs and minor argillite outcrop along the W. shore of Gwillim lake. Sills of coarse-grained gabbro and diorite and of serpentinized pyroxenites and dunites are present in the central part of the area.

N. of Elaine lake, these older rocks are overlain by remnants of Proterozoic-type formations, which consist of conglomerates, arkoses and graywackes belonging to the Chibougamau series.

A number of interesting discoveries of metallic minerals have been made in this area and a large number of mining companies have undertaken, during the last 15 years in particular, exploration work of many kinds, varying from simple prospecting to diamond drilling. The work of 6 mining companies is briefly described.--From auth., p. 2, 10.

3-757. Laurin, A.F. PRELIMINARY REPORT ON TURQUETIL-ÉMARD AREA, PONTIAC ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 424, 9 p., fold. geol. map, (Prelim. Map no. 1334), scale 1:63,360, table, 1960, 5 refs.

This 410 sq. mi. area (47°-47°15'N. 76°15'-76°45'W.), about 120 mi. NW. of Hull, was mapped in 1959. Consolidated rocks are all Precambrian. Among the oldest are mafic and feldspathic paragneisses, crystalline limestone, and garnetiferous quartzites, with minor amounts of hornblendic and pyroxenic gneisses. Injection gneisses are widespread in the paragneisses. Granitic gneisses scattered throughout the area are, in part, closely related to some of the injection gneisses. Within the paragneisses and the injection gneisses are numerous lenticular masses and one irregular body of metagabbro. Nepheline syenite forms a small crescentic lens in the amphibolitic gneiss. Pink, massive granite and pink pegmatite are the youngest consolidated rocks in the area.--From auth., p. 2.

3-758. Moyer, Paul T., Jr. PRELIMINARY REPORT ON THE GUYON AREA, MISTASSINI TERRITORY: Quebec, Dept. Mines, Prelim. Rept. no. 427, 8 p., fold. geol. map (Prelim. Map no. 1337), scale 1:63,360, table, 1960, 3 refs.

The Guyon area (50°30'-50°45'N. 73°30-74°W.), mapped in 1959, covers 374 sq. mi., about 45 mi. NNE. of Chibougamau. The area straddles the southeastern part of the Mistassini trough. In the SE. it includes the contact between dolomitic rocks of the Mistassini group and the metamorphic rocks of the Grenville subprovince, and, near the NW.

corner, it includes the contact between the Mistassini group and a metamorphic complex of the Temiskaming-Keewatin subprovince.

The metamorphic rocks of the Grenville subprovince, although restricted to a relatively small portion of the area, are represented by diverse and numerous types of gneisses. The 2 most abundant rock types are biotite-quartz-feldspar gneiss and quartz-feldspar paragneiss. Rocks of the Temiskaming-Keewatin subprovince are chiefly hornblende-quartz metadiorite, with minor amounts of more mafic rocks.

The Mistassini group unconformably overlies both the Grenville and the Temiskaming-Keewatin rocks. This group is made up of more or less stratified, pink and gray dolomite, grading in places into shaly or sandy members. In most places, the beds dip gently E.-southeastward, but they steepen abruptly in this direction where they form a sharp contact with the metamorphics of the Grenville subprovince.

Glacial deposits, including drumlins, eskers, kames, and till plains, blanket most of the area, and rock outcrops are scattered.--From auth., p. 2.

3-759. Sabourin, R.J.E. PRELIMINARY REPORT ON POMMEROY-BELLEFEUILLE AREA, TEMISCAMINGUE ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim, Rept. no. 423, 7 p., fold. geol. map (Prelim. Map no. 1335), scale 1:63,360, table, 1960, 3 refs.

This 305 sq. mi. area (47°-47°15'N. approx. 78°30'W.) was mapped in 1959. All the consolidated rocks are Precambrian. The oldest, outcropping in the NW. corner, consist of fine-grained hornblende and biotite schists and gneisses with possibly some volcanics. Biotite and hornblende paragneisses, some of which are garnetiferous, outcrop as continuous bands in the S.-central part of the area and as lenses and layers in the gray granite gneiss and pink granite. Quartzite forms a continuous band that outlines the basin structure of the southern part of the area; it also occurs on the W. side of Saseginaga lake. Associated with the paragneisses are some bands of garnetiferous pink granitic gneiss. A gray biotite granite gneiss, the most extensive rock of the area, intrudes these formations and is in turn cut by pink granite. Gabbro sills and dikes, more or less altered, are widespread. NW.-trending diabase dikes are the youngest intrusive rocks.--From auth., p. 2.

3-760. Jahns, Richard H., ed. GEOLOGY OF SOUTHERN CALIFORNIA: California, Div. Mines, Bull. 170, 2 v.: v. 1, text; v. 2, maps, pls., 5 geol. guides, Sept. 1954, reprinted 1959, refs.

The volume is intended to provide a broad sampling of geological features and thought, as they relate to the southern California region, and its contents reflect an approach that is partly geographic and partly topical. Emphasis is placed on a wide variety of contributions by investigators qualified to make authoritative presentations and interpretations of data; there are 103 contributors.

Southern California is regarded as the region occupied by Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura counties, although a few of the contributions deal with parts of adjacent counties.

The 10 chapters of the book comprise 62 papers that deal with physical geography, general geology of the natural provinces, historical geology and stratigraphy, geologic structure, geomorphology, mineralogy and petrology, hydrology, oil and gas, mineral deposits, and engineering geology. Some of the individual contributions are general in scope, others deal with specific areas or problems, and most contain information hitherto unpublished. Supplementing the main part of the book is a group of 34 map sheets of selected areas; each sheet includes a geologic map, which in general is accompanied by other illustrative material and a brief text.--From pref.

Five detailed separate geologic guides are included for those interested in field excursions through typical parts of the coastal and interior regions. They are:

1) Wright, Lauren A., and Bennie W. Troxel. Western Mojave Desert and Death Valley Regions.
2) Jennings, Charles W., and Bennie W. Troxel. Ventura Basin and Adjacent Areas.
3) Troxel, Bennie W. Los Angeles Basin.
4) Bandy, Orville L., and Kenneth O. Emery. Southwestern Part of the Los Angeles Basin.
5) Jahns, Richard H. Northern Part of the Peninsular Range Province.

3-761. Southeastern Geological Society. NINTH FIELD TRIP. GUIDEBOOK, LATE CENOZOIC STRATIGRAPHY AND SEDIMENTATION OF CENTRAL FLORIDA. Edited by Harbans S. Puri: 131 p., maps, secs., chart, diag., graphs, tables, P.O. Box 641, Tallahassee, Florida, May 1960, refs.

Contains 6 papers, an abstract of a paper on "Characteristics of Kaolinitic Sediments in Peninsular Florida and Immediate Origin of the Kaolin," by E.C. Pirkle, and descriptive road logs by E.W. Bisop, E.C. Pirkle, and H.K. Brooks. The complete papers are abstracted separately below in the order in which they appear in the guidebook.

3-762. Puri, Harbans S., and Robert O Vernon. NOTES ON THE SURFICIAL GEOLOGY OF CENTRAL PENINSULAR FLORIDA (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 1-31, map, chart, sec., diag., table, Tallahassee, Florida, May 1960) 29 refs.

Physiographically, the area covered in this paper is the Central Highlands. These highlands consist of the Lake Wales ridge, the Winter Haven ridge, the Lakeland ridge, the Brooksville ridge, and the Orlando ridge. The highlands are characterized by relatively great relief and numerous solution-hole lakes. Elevations in this area range from 40 ft. to as much as 300 ft. Locally, the area embraces segments of undissected marine plain.

Limestones of the Williston formation (Jackson, Eocene) are the oldest segments exposed in this area. The Crystal River formation overlies the Williston unconformably. Sediments of Oligocene and early Miocene age are represented by the Suwannee limestone. The Miocene rocks overlie the Oligocene limestone unconformably, and these sediments are represented by St. Marks formation of the Tampa stage. The Alum Bluff stage is represented by the unnamed coarse clastics, the Hawthorn formation, and the Alachua formation. The Bone Valley formation overlies the Hawthorn and is represented by the phosphatic conglomerate, which is usually embedded in a sandy or plastic clay matrix and the overlying stratified phosphoritic beds. The beds of Pleistocene age overlie the Miocene unconformably and are represented by the "Citronelle formation" in the northern part of the area. Unsorted, generally uncemented quartz sand, with some seams of clay, represent the marine terrace deposits that overlie the "Citronelle."

The central peninsular area of Florida is the principal source of phosphate in the state. The most abundant of the phosphate minerals is apatite. The greatest production of the phosphate is from the land-pebble phosphate deposits which occur in the sands and clays of the Miocene Hawthorn and Bone Valley formations. Kaolin occurs in the lower part of the unnamed coarse clastics and is mined commercially.

Florida's production of construction sand is mainly from the unnamed coarse clastics of the central peninsular area.--Auth.

3-763. Brooks, H.K. SIZE FREQUENCY DISTRIBUTION OF PARTICLES IN SEDIMENTS OF THE "CITRONELLE FORMATION" (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 32-35, 12 graphs, Tallahassee, Florida, May 1960) 3 refs.

The results of mechanical analysis of the kaolinitic sands and pebbly sands are presented as histograms to show the textural variability of the different lithologic components of the "Citronelle formation" (Pleistocene) exposed at the Diamond Interlachen Sand Co. pit, sec. 16, T. 10 S., R. 24 E., Putnam County, Florida.--Auth.

3-764. Bishop, E.W. THE GEOCHEMISTRY OF PHOSPHORUS (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 38-49, Tallahassee, Florida, May 1960) 11 refs.

P is one of the most abundant and important minor elements in the earth's crust. The principal P mineral is fluorapatite. As a rule, the amount of P in igneous rocks is controlled by the acidity of the rocks. Basalts are relatively high, intermediate rocks medium, and very acidic rocks low in contained P. An exception to the rule is the abundance of P in acid and intermediate pegmatites.

P is of prime importance in the biosphere as it is an essential constituent of all living matter. Plants obtain soluble P from the soil, where it has been liberated from rocks by weathering. Animals obtain P from plant products. Bacteria and fungi have exceptionally high content (22,000 to 25,000 p.p.m.) of P and are important agents in the circulation of P in soils.

The P content of sea water varies with depth from zero at the surface to more than 80 p.p.m. at about 10,000 ft. Deep ocean water, which is believed to be saturated with P, forms great reservoirs of this element. Fresh water is thought to be generally low in P content. The P content of sediments deposited under open ocean conditions is usually low and generally ranges from about 150 p.p.m. to about 1,300 p.p.m.

Sedimentary phosphorite deposits are thought to represent special conditions of marine deposition. The solubility of P and Ca is strongly controlled by the pH of the surroundings. The solubility curves for phosphate and calcium carbonate are similar and parallel, with the solubility of phosphate being much less than that of calcium carbonate. Under special conditions of reduced pH, such as could prevail in restricted basins, phosphate rather than calcium carbonate could be the principal sediment. Phosphate deposits may also result from the accumulation of remains and excrement of animals and birds.--Auth.

3-765. Reves, William D. AN X-RAY STUDY OF TWO FLORIDA LAND PEBBLE PHOSPHATE SAMPLES (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 50-63, 3 tables, Tallahassee, Florida, May 1960) 19 refs.

A series of 37 X-ray photographs were made of the clay minerals occurring in the closed chambers of 2 phosphate pebbles from the Florida phosphate field. As has been reported by previous workers, attapulgite was present. The presence of this clay mineral in the closed chambers tends to confirm the belief that attapulgite was present during the time of lithification of the parent rock of the Miocene Bone Valley formation and also that a Mg environment persisted from the time of deposition of the parent rock until the development of the Bone Valley. It appears from this cursory selective study that attapulgite is changing to montmorillonite in the intermediate horizon of the Bone Valley formation and that montmorillonite is altered to kaolinite in its upper beds.--Auth.

3-766. Bishop, E.W. STRUCTURE AND DIADOCHIC SUBSTITUTIONS IN THE APATITE GROUP (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 64-74, fig., Tallahassee, Florida, May 1960) 21 refs.

The minerals species of the apatite group are in the hexagonal bipyramidal class of the hexagonal system and have the chemical formula $A_{10}(XO_4)_6Z_2$. The apatites show chemical variation in terms of: 1) A = Ca, Pb, Na, K, C, and Sr; 2) X = P, As, V, S, Si, and C; and 3) Z = F, Cl, and OH.

Members of the apatite group are isostructural with fluorapatite. The substitution of larger ions generally results in an enlargement of the unit cell.

The unit cell of fluorapatite, $Ca_5(PO_4)_3F$, has the dimensions a_0 9.36 kX, c_0 6.88 kX, and contains 10 Ca, 6 P, 2 F, and 24 O. P occurs in tetrahedral coordination with O in a nesosilicatelike structure. Ca occurs in 2 different positions: 1) in sevenfold coordination with 6 O and 1 F, and 2) in sixfold coordination with O. The bonding of the cell is from P to O to Ca to F.

Diadochic substitutions as related to fluorapatite are: 1) Pb, Na, K, C, and Sr for Ca; 2) As, V, S, Si, and C for P; and 3) Cl and OH for F.--Auth.

3-767. Goodell, H.G., and J.W. Yon, Jr. THE REGIONAL LITHOSTRATIGRAPHY OF THE POST-EOCENE ROCKS OF FLORIDA (In: Southeastern Geological Society. Ninth Field Trip. Guidebook...: p. 75-113, 4 maps (2 col.), 6 secs., Tallahassee, Florida, May 1960) 18 refs.

Lithologic cross sections and correlations of those strata lying on top of the upper Eocene or older rocks of Florida are presented together with their lithofacies. Two main interfingering lithosomes are responsible for the resulting facies patterns. Basal and basinal downdip are bioclastic limestones which intertongue over tectonic hingelines with upper and updip shelf terrigenous clastics which are somewhat heterogeneously composed of sandy phosphoritic green clay, sands and light colored lenses of clay. Oligocene and lower Miocene tectonic stability is succeeded by unstable tectonic conditions during middle Miocene. Over-all Oligocene transgression of the sea is followed by sporadic withdrawal during all of post-Oligocene, with the resulting fluctuation of strandlines. Terrestrial clastics encroach upon the panhandle and peninsula beginning in latest lower Miocene and continue to increase in dominance throughout and following that epoch, as marine conditions moved intermittently but steadily S. Facies patterns and the parameters of sedimentation are interpreted in light of these tectonics.--Auth.

3-768. Bloom, Arthur L. **THE GEOLOGY OF SEBAGO LAKE STATE PARK:** Maine Geol. Survey, State Park Geol. Ser. no. 1, 24 p., 10 illus., map, 8 diags., chart, 1959.

This pamphlet, written in semipopular style, describes the geology of the Sebago Lake State Park area in Maine. Special emphasis is placed on surface features developed by Pleistocene glaciation which would be of interest to tourists and campers visiting the park. Contents are as follows: introduction; geologic history; features of geologic interest in the State Park area - bedrock types, a glacial erratic, till, a glacial kettle, Songo River valley, beaches.--M. Russell.

3-769. **ASPECTS OF THE GEOLOGY OF TEXAS: A SYMPOSIUM:** Texas, Univ., Pub. 6017, 117 p., 66 figs., 6 pls., Sept. 1960, refs.

The papers contained in this volume were presented at the University of Texas, Oct. 31, 1958. One paper, "Deposition and Alteration of the Edwards Limestone, Central Texas," by Henry F. Nelson, is included in abstract form only, because it was published separately, as University of Texas, Pub. 5905 (GeoScience Abstracts 1-1149).

For this symposium papers were sought presenting new concepts or techniques in geology or new information on little known parts of Texas. It is hoped that these papers will stimulate advanced thinking on the geological problems of Texas which must be solved if the state is to retain its prominent position as a producer of petroleum, natural gas, and industrial rocks and minerals upon which its economy so largely depends."-- From foreword by J.T. Lonsdale and S.P. Ellison.

The 5 papers are abstracted separately below in the order in which they appear.

3-770. Conselman, Frank B. **PENNSYLVANIAN REEF PATTERNS IN WEST-CENTRAL TEXAS** (In: Aspects of the Geology of Texas: A Symposium: Texas, Univ., Pub. 6017, p. 1-13, 11 figs., Sept. 1960, 18 refs.

The recognition of reefs has been based on many different criteria, but the reef concept is basically a very simple one. In actual practice, a reef is identified by its form and may be defined as a carbonate body whose upper surface is markedly convex, as a result of predominantly organic marine sedimentary processes.

W.-central Texas Pennsylvanian reefs may be classified into 5 categories: ridge reefs, "button" or round reefs (bioherms), chain or cluster reefs, atolls, and irregular or composite reefs. Examples of these patterns are the Jameson reef (ridge), Double Mountain reef ("button" or round), the reef system S. of Merkel, Taylor County (chain or cluster), Horseshoe atoll (atoll), Round Top Canyon reef (irregular or composite), and others.

The physical parameters of reefs are useful in the statistical approach to reef classification and recognition. By directly observed quantitative criteria, stratigraphic carbonate anomalies of reefoid character are classified as follows: 1) If contour closure equals or exceeds 100 ft. per mi. of width, the deposit is a reef. 2) If contour closure is 50 to 100 ft. per mi. of width, the deposit is probably a reef. 3) If contour closure is less than 50 ft. per mi. of width, the deposit is a bank or biostrome.

The physical parameters may be presented in a convenient shorthand tabulation, for example, 6 x 2/8 @ 3, which describes a reef 6 mi. long and 2 mi. wide with 800 ft. of relief and a bearing of 30°.--Auth.

3-771. Martinez, Joseph D., and others. **A REVIEW OF PALEOMAGNETIC STUDIES OF SOME TEXAS ROCKS** (In: Aspects of the Geology of Texas: A Symposium: Texas, Univ., Pub. 6017, p. 15-47, 29 figs., Sept. 1960) 16 refs.

The various mechanisms by which rocks acquire a permanent or remanent magnetization are briefly reviewed. The positions of Mesozoic, Paleozoic, and Precambrian poles deduced from measurements of remanent magnetism on a world-wide basis by various workers is summarized. A short discussion covers the lines of reasoning which suggest that the ancient magnetic pole locations are generally coincident with the time equivalent geographic poles if a sufficiently long time interval has been included in the sampling.

The results of paleomagnetic studies at the Humble Research Center of a large number of varied rock types occurring in Texas are summarized and in certain instances discussed in some detail. The bulk of these measurements involve sedimentary rocks, but many igneous rocks and some metamorphics have also been investigated. While some data previously published are reviewed, this paper includes much material not yet published.

The new work reported on here includes paleomagnetic studies made of Tertiary volcanics in the Big Bend National Park. The purpose of this work was to test (and use where possible) paleomagnetic data for correlation purposes.--Auth.

3-772. Nicholson, John H. **GEOLOGY OF THE TEXAS PANHANDLE** (In: Aspects of the Geology of Texas: A Symposium: Texas, Univ., Pub. 6017, p. 51-64, 8 figs., 4 pls., Sept. 1960) 12 refs.

The Amarillo uplift in the center of the Panhandle and the Matador arch near the southern limit are dominant structures. The Amarillo uplift connects with the Wichita Mountains of Oklahoma and is en echelon with the Bravo dome, an element of the Sierra Grande uplift of New Mexico. The Matador arch parallels the Red River arch of N. Texas and Milnesand dome of New Mexico. There are 3 basins in the Panhandle: deep Anadarko basin N. of the Amarillo uplift; shallow Dalhart basin in the NW. Panhandle; and Palo Duro basin between the Amarillo and Matador structures. Secondary structures oblique to the Amarillo uplift occur in adjacent basins.

The Texas Peninsula was a broad arch until Mississippian time; structural activity responsible for basins and uplifts commenced in Late Mississippian and culminated in Middle Pennsylvanian (Des Moines) time.

A relatively complete section of pre-Pennsylvanian rocks occurs in the Anadarko basin; the Palo Duro and Dalhart basins contain only Cambrian, Ordovician, and Mississippian sediments. Early and Middle Pennsylvanian clastics eroded from rising structures were trapped in adjacent basins, with some carbonates deposited away from clastic sources. Late Pennsylvanian carbonate deposition dominated shelf areas of subsiding basins; fine clastics accumulated in the center of basins. Shallow-water deposits covered the basins in Late Pennsylvanian, followed by subsidence and renewed carbonate deposition during Wolfcamp (Permian) time; post-Wolfcamp Permian deposits are evaporites and terrigenous clastics. Regional uplift was followed later by deposition of Triassic and Cenozoic nonmarine rocks. --Auth.

3-773. Wilson, James Lee, and O.P. Majewske. CONJECTURED MIDDLE PALEOZOIC HISTORY OF CENTRAL AND WEST TEXAS (In: Aspects of the Geology of Texas: A Symposium: Texas, Univ., Pub. 6017, p. 65-86, 5 figs., 2 pls., Sept. 1960) 38 refs.

Regional Siluro-Devonian faunal correlations between outcrops in the Llano uplift of Texas, the Arbuckle Mountains of Oklahoma, and the Trans-Pecos Texas-southern New Mexico mountains are made with strata of the W. Texas subsurface whose faunas have recently been studied. These correlations are based upon outcrop areas generally representing tectonic shelves with thin, incomplete, but fossiliferous limestones as well as the thicker but less fossiliferous strata of marginal cratonic basins.

The major segments of middle Paleozoic strata in the southwestern states are: 1) A widespread thin pure carbonate sequence of Lower Silurian (Alexandrian) and lower Niagaran age. 2) A lithologically diverse and thicker unit of Middle and Upper Silurian (Niagaran) age represented by marls and thin limestones and in parts of W. Texas and all of New Mexico by massive dolomitized platform-type carbonates. 3) An unconformity above the Silurian at the position occupied by the evaporites of the Michigan and New York basins. This is present also in the W. Texas and Anadarko basins. 4) A widespread unit of fossiliferous, generally limestone, strata of Lower Devonian through Onondagan age, thin in the Ozark, Arbuckle, and Llano uplift areas, but as much as 1,100 ft. thick in the W. Texas basin. 5) A second major unconformity of late Middle Devonian age as widespread as the Siluro-Devonian one. 6) A widespread sheet of relatively thin argillaceous and siliceous deposits typical of the Devono-Mississippian black shales of the Midcontinent. These Woodford deposits grade westward into argillaceous limestones in New Mexico and W. Texas.

From isopach and subcrop maps of these major stratigraphic sediments the presence of the Paleozoic Texas craton may be inferred. The Kerr and Fort Worth basins on its margins are apparently post-middle Paleozoic features. Silurian beds were more restricted than Devonian and are overlapped by the latter over the Texas craton and in the eastern Arbuckle Mountains. It may be conjectured that the faunal differences between W. Texas and Hunton Silurian beds are in part caused by deposition in separate basins. The older Devonian of the SW. is correlative eastward with the Appalachian section, and the seas extended into the W. Texas basin, where a thick section is preserved. However, Lower and lower Middle Devonian is not present in New Mexico outcrops, and the seas probably did not extend this far W. The Woodford covered the entire area after a Middle Devonian erosion period.--Auth.

3-774. Young, Addison. PALEOZOIC HISTORY OF THE FORT STOCKTON-DEL RIO REGION, WEST TEXAS (In: Aspects of the Geology of Texas: A Symposium: Texas, Univ., Pub. 6017, p. 87-109, 13 figs., Sept. 1960) 7 refs.

Throughout Paleozoic time to the close of the Mississippian, the Fort Stockton-Del Rio region experienced only mild structural activity; the associated sedimentary rocks are relatively thin and consist chiefly of carbonates except for the dark shale of the Woodford and overlying younger Mississippian sediments. In Early Pennsylvanian time a major geosyncline developed, was filled with thick clastic sediments, and was later compressed into the Marathon folded belt. In early Permian Wolfcamp time the final phase of this late Paleozoic orogeny occurred. The Val Verde geosyncline formed principally during this time and received at least 14,000 ft. of clastic sediments. It is N. of the older geosyncline and is the main structural feature of the Fort Stockton-Del Rio region. After Wolfcamp time the region returned to a condition of crustal quiet. This Paleozoic history has been revealed mostly by wells drilled in the past few years for oil and gas, among which is the deepest boring ever sunk into the earth. --Auth.

3-775. Germanyuk, M.M., and others. NEW DATA ON THE GEOLOGY OF SOUTHEASTERN TURKMENIA: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 79-83, map, sec., 3 profiles, 1959, pub. 1960.

Some data are presented on the stratigraphy and lithology of the Mesozoic and Tertiary sequences of southeastern Turkmenia, U.S.S.R., together with information on anticlines, uplifts, and downwarps found.--C. Voûte.

2. GEOMORPHOLOGY

See also: Geologic Maps 3-717; Mineralogy 3-897, 3-900; Sedimentary Petrology 3-913; Fuels 3-973.

3-776. Hibbard, Claude W. AN INTERPRETATION OF PLIOCENE AND PLEISTOCENE CLIMATE IN NORTH AMERICA: Michigan Acad. Sci., Arts & Letters, Ann. Rept. 62, 1959-1960, p. 5-30, 2 figs., pl., 1960.

Fossil giant land tortoises (Geochelone), where found, indicate winter temperatures above freezing during Pliocene and Pleistocene in High Plains region, North America. Caliche formed during arid intervals. Climatic events in High Plains were:

Moist subtropical climate; winter temperatures not below 32°F., if as low; NW. to Bennett County, South Dakota, during lower Pliocene (Clarendonian).

Moist subhumid climate; winter temperatures not below 32°F.; NW. to Cherry County, Nebraska, during lower and middle middle Pliocene (Hemphillian).

A late Hemphillian shift to semi-aridity, followed by aridity in High Plains of Texas, Oklahoma, and Kansas at close of Hemphillian.

Difference between lower Pliocene and middle Pliocene climates due to great reduction in precipitation and increased summer temperature, not decrease in winter temperature.

Return during part of upper Pliocene to more equable, subhumid climate; winter temperatures seldom below 32°F., N. to SW. Kansas and probably into northern Nebraska. Aridity followed, producing extensive caliche; then a postcaliche subhumid climate with winter extremes milder than now.

Nebraskan and Kansan winter temperatures milder than Illinoian in southern High Plains. Present extreme winter temperatures developed during Wisconsin.

Geochelone in First Interglacial (Aftonian) Sand Draw local fauna, Brown County, Nebraska, indicates winter temperatures rarely if ever below 32°F. Large tortoises of second (Yarmouth) and third (Sangamon) interglacials of SW. Kansas indicate mild winter temperatures seldom reaching freezing.

Late Aftonian, Yarmouth, and Sangamon aridity produced extensive caliches. Arid intervals of each interglacial followed by more equable subhumid climates.

Predicts we are only entering an interglacial interval - warmer climate to follow. Semiaridity of southern High Plains should shift slowly to aridity when extensive caliche will form; aridity to be followed by more equable climate with mild winters, cooler summers, and increased precipitation.--J. A. Dorr, Jr.

3-777. Gray, Jane. **EARLY PLEISTOCENE PALEOCLIMATIC RECORD FROM SONORAN DESERT, ARIZONA: Science, v. 133, no. 3445, p. 38-39, table, Jan. 6, 1961, 7 refs.**

Three pollen spectra from lake sediments stratigraphically well below mid-Kansan fauna indicate plant associations for the Sonoran desert, approximating those found now at elevations of 1,500 ft. and more above the desert floor. The presence of Ostrya, Betula, and Artemisia may indicate some invasion by northern species as well. A climate cooler or wetter, or both cooler and wetter, than the present climate is inferred from paleobotanical and sedimentary evidence. Correlation with the Nebraskan glacial stage is tentatively suggested.--Auth.

3-778. Ives, J.D. **THE DEGLACIATION OF LABRADOR-UNGAVA - AN OUTLINE: Cahiers de Géographie de Québec, v. 4, no. 8, p. 323-343, 15 illus., 6 maps, Apr.-Sept. 1960, 28 refs.**

Based upon studies of aerial photographs and field work carried out over a 5-year period by various members of the research staff of the McGill Sub-Arctic Research Laboratory, main lines are drawn along which the deglaciation of all Labrador-Ungava peninsula took place. This region formed a major center of ice accumulation and dispersal and one of the final centers of wastage. The areas studied extend from the Torngat mountains, which partly protruded through the icecap and where the earliest signs of retreat of the ice could be observed, to the plateau NNW. of Schefferville, where disintegration and stagnation of the final remains of the continental ice sheet took place. The distribution is indicated of the areas which remained ice free. Successive phases of thinning of the ice and of increasing stagnation of the glaciers have been recorded. Large proglacial lakes were formed between the retreating inland ice covering Ungava Bay and Labrador plateau and the high coastal areas. A systematic study of the Schefferville area revealed a pattern of subglacial drainage channels and the approximate position of the ice divide. It is concluded that the climate during the final stage of ice wastage was somewhat warmer than it is today. No attempt is made to correlate the events recorded with the standard American chronology.--C. Voûte.

3-779. Cook, Frank A. **GEOGRAPHICAL BRANCH STUDIES IN PERIGLACIAL GEOMORPHOLOGY: Cahiers de Géographie de Québec, v. 4, no. 7, p. 209-210, Oct. 1959 - March 1960, 33 refs.**

A short survey of past and present studies in the field of periglacial geomorphology undertaken in Canada, mostly after 1950.--C. Voûte.

3-780. Brown, R.J.E. **THE DISTRIBUTION OF PERMAFROST AND ITS RELATION TO AIR TEMPERATURE IN CANADA AND THE U.S.S.R.: Arctic, v. 13, no. 3, p. 163-177, 9 maps, table, Sept. 1960, 16 refs.**

Permafrost is any material in the earth's crust that remains frozen over many years. It occurs in the northern areas of North America and Eurasia and in Antarctica. The permafrost region can be divided into continuous and discontinuous zones. The thickness of permafrost varies with location, being very deep in the Arctic and thinning out at its southern limit. It is characterized by a surface layer, called the active layer, which alternately thaws and freezes with the seasons. Prior to World War II, the only map showing the distribution of permafrost in Canada was produced in the U.S.S.R. The construction of the Alaska Highway and other projects in the North stimulated Canadian and American interest in permafrost. Since the war, scientific and engineering investigations have continued, and various maps have been drawn. The first map of permafrost distribution in the U.S.S.R. was compiled in 1927. A widespread program of borings and soil temperature installations since then has resulted in detailed maps showing distribution and thickness. For several years, the Division of Building Research, National Research Council, Canada, has been conducting investigations on permafrost distribution in Canada. Field observations and literature references have been applied, resulting in a map of the approximate distribution of the continuous and discontinuous zones. There is not direct correlation between permafrost distribution and air temperature either in Canada or the U.S.S.R. Examination of the southern limit, as known at present, and of air temperature patterns and freezing and thawing indices, reveal the existence of a very broad relationship.--Auth.

3-781. Gould, Howard R., and Thomas F. Budinger. **CONTROL OF SEDIMENTATION AND BOTTOM CONFIGURATION BY CONVECTION CURRENTS, LAKE WASHINGTON, WASHINGTON: Jour. Marine Research, v. 17, p. 183-198, illus., 2 maps, 2 secs., 1958, pub. 1960, 10 refs.**

Lake Washington near Seattle occupies a deep narrow trough sculptured by the Vashon ice sheet, the last continental glacier to invade the Seattle area.

Extending along the center of the trough is a broad ridge that stands 5 to 30 ft. above narrow valleys on either side. Thus, the trough in cross-section is W-shaped rather than U-shaped, as are most glacial valleys. The sediments in the trough consist of blue clay, locally more than 100 ft. thick, overlain by limnic peat or gyttja 5 to 55 ft. thick. The blue clay consists of rock flour of meltwater origin, and the limnic peat consists of planktonic organisms that began to accumulate following the meltwater stage. Within the limnic peat are a layer of volcanic ash and an overlying layer of varved peat, each about 2 in. thick. Radiocarbon analyses place the age of the ash at 6,700 years and that of the blue-clay peat contact at 13,650 years. The estimated age of the varved layer is 5,000 years. Core profiles across the lake show that the trough was U-shaped at the close of blue-clay deposition and that the W-shaped profile had approximately its present configuration at the time of the ash fall. Investigations of the lake-temperature structure, together with certain distinctive features of the lake topography and sediments, point to convection currents as being the agents responsible for the observed inequalities in limnic-peat sedimentation which, in turn, account for the unusual W-shaped configuration of the trough floor.--Auth.

3-782. Simonett, David S. DEVELOPMENT AND GRADING OF DUNES IN WESTERN KANSAS: Assoc. Am. Geographers, Annals, v. 50, no. 3, p. 216-241, illus., 5 maps, sec., diag., 9 graphs, 4 tables, Sept. 1960, refs.

At the beginning of this study the thesis is put forward that some of the most complex dune types and some of the more complex dune gradings might be found in the midcontinent steppes in dunes with a discontinuous grass and low shrub cover. To what extent have these expectations been realized in western Kansas?

In both form and origin the dunes between Syracuse and Cimmaron are indeed complex. The presence of an active sand-binding vegetation, numerous blowouts, and periodic free dune migration, coupled with reversals in wind direction in sympathy with the glacial advance and retreat of the Wisconsinan period have helped produce a jumbled, chaotic dune landscape. Although the dominant sand-moving winds of the present are from the S., the dunes were built largely by N. winds which stripped sand from the Wisconsinan alluvials of the Arkansas River and to some extent reworked the pre-Peorian sands lying on the Kansan terrace where it was possible to scour away the Peorian loess mantle. The major advance southward over the Peorian loess involved the sand sources as noted above and may have started as early as late pre-Bradyan.

The expectation that the sand gradings might also be very complex in these dunes was not fully realized. Many features of the gradings agree quite closely with those of desert dunes in which vegetation has played no part in dune development. The improvement in regularity and in narrowness of grading with movement away from the source, the steeper grading on the fine side in the crest sites compared with the slopes, and the wide range of sand sizes and imperfect grading of the trough sands, all are as typical of desert dunes as of these vegetated dunes. In 2 major respects, however, the gradings may fairly be regarded as complex. The anomalous crest-slope relation in the northern CW series in which the coarse side grading of the slope sands is steeper and more regular than the crest sands is one feature which has apparently not been recorded of desert dunes. Also, the differences in peak diameters between the vegetated dunes and the Kendall barchan pose many questions which this study does not answer satisfactorily.

In addition to the above problems there are several others this discussion has touched upon which demand further study. There is already some evidence that very fine sands composed of particles within the range of 0.08 to 0.15 mm. do not behave in the same manner as coarser sands, particularly with respect to differences between crest and slope peak diameters. It is probable too that very coarse sands (from 0.5 to 2.0 mm.) may give rise to dune gradings unlike those of the majority of dunes which have their predominant diameter between 0.15 and 0.30 mm. Finally, while we may speculate on the role of dune height, and on the function of gravity slope sorting and of dune spacing in affecting gradings, it is all too evident that we are merely speculating. Studies aimed at quantifying the part played by these factors in dune gradings can no longer be deferred.--Auth. concl.

3-783. Hinds, Norman E. A. EVOLUTION OF THE CALIFORNIA LANDSCAPE: California, Div. Mines, Bull. 158, 240 p., 156 figs. incl. illus., maps, secs., profiles, diags., 1952, reprinted 1960, refs.

This volume attempts to bring together information about the various parts of the state for the layman who wants to learn more about places he has seen or may see. Abundant pictures, sketches, and diagrams are included.

Because of California's huge area, studies of many parts are incomplete or not even made, so we have only a partial picture of how the landscape reached its present form. Enough information is available so that all of the major divisions can be described in general outline at least.

This discussion of the landscape of California is concerned principally with events which took place during the Cenozoic era, but some dating as far back as the Jurassic and Cretaceous are also of great significance. In landscape evolution, the first imprints recognizable in California today were made in Jurassic time, when the ancestors of the Klamath Mountains, the Sierra Nevada, part of the Transverse Ranges, the Peninsular Ranges, and some other ranges appeared.--From introd.

Chapters are: Sierra Nevada, Basin-Ranges, Mojave Desert, Colorado Desert, Modoc Plateau, Cascade Range, Klamath Mountains, Great Valley, Coast Ranges, Transverse Ranges, Peninsular Ranges, and Sea Floor.

3-784. Buckman, Harry O., and Nyle C. Brady. THE NATURE AND PROPERTIES OF SOILS. A COLLEGE TEXT OF EDAPHOLOGY: 6th ed., 567 p., illus., maps, profiles, diags., graphs, tables, New York, Macmillan, 1960, refs.

The changes made in this edition are related to bringing the text up to date scientifically and to improving the presentation. The chapters dealing with clay minerals, soil water, soil pH, weathering, and soil nitrogen have been revised to incorporate new concepts resulting from research. In all other chapters less extensive modifications have been made to bring the subject matter up to date. Throughout the text new photographs, diagrams, and figures have been used to present the subjects of soil science in a more simplified manner. In general, the concepts presented are based on sound research data and the terminology used is of the same level as that found in an elementary college chemistry text. Students using this text should have a sufficient knowledge of elementary chemistry, physics, and geology to understand simple chemical formulae and equations. Two subjects - micronutrients and soil survey interpretation - are given more attention in this edition.--From pref.

Contents: soil in perspective; supply and availability of plant nutrients in mineral soils; some important physical properties of mineral soils; soil colloids, their nature and practical significance; organisms of the soil; organic matter of mineral soils; forms of soil water, movement and plant relationships; vapor losses of soil moisture and their regulation; liquid losses of soil water and their control; soil air and soil temperature; origin, nature, and classification of parent materials; soil formation, classification, and survey; organic soils, nature, properties, and utilization; the soil reaction, soil acidity and alkalinity; lime and its soil-plant relationships; nitrogen economy of soils; supply and availability of phosphorus and potassium; micronutrient elements; fertilizers and fertilizer management; farm manure and green manure; fertility management of mineral soils.

3-785. Sim, Victor Wallace. MAXIMUM POSTGLACIAL MARINE SUBMERGENCE IN NORTHERN MELVILLE PENINSULA: Arctic, v. 13, no. 3, p. 178-193, 3 illus., 5 maps, 2 tables, Sept. 1960, 17 refs.

Coastal areas of Melville Peninsula, Keewatin District, Northwest Territories, Canada, were submerged during immediate postglacial time. Since then an isostatic recovery of approximately 450 ft. has been recorded. The amount of this recovery was measured using the following 4 main criteria: 1) the highest altitude at which marine shells occur, 2) the highest altitude at which strandlines are preserved, 3) the lowest altitude at which undisturbed ground moraines can be recognized, and 4) the lowest altitude at which perched boulders are found. The mean value for all observed elevations of the highest marine shells indicates an emergence of 404 ft. A mean value for all observed elevations of the highest strandlines suggests an emergence of 440 ft. Undisturbed ground moraine and perched boulders were the most easily applied and most valuable limiting criteria. The mean value for all observations by the former method indicates a postglacial marine limit at 466 ft. and by the latter at 454 ft. In general the elevations obtained for the marine limit in northern Melville Peninsula are more than 100 ft. lower than those determined for Southampton Island. During maximum submergence the entire eastern Paleozoic lowland, with one local exception, was beneath the sea. So also was the lowland bordering Fury and Hecla Strait. Arms of the sea penetrated a few miles up the main river valleys which now drain E. and W. across the Precambrian surface of the peninsula.—Auth.

3-786. Collin, Arthur Edwin. OCEANOGRAPHIC OBSERVATIONS IN THE CANADIAN ARCTIC AND THE ADJACENT ARCTIC OCEAN: Arctic, v. 13, no. 3, p. 194-201, 3 maps, profile, 2 graphs, Sept. 1960, 16 refs.

A short summary of the development of oceanographic research in the Canadian Arctic Archipelago and a brief description of oceanographic conditions throughout the Queen Elizabeth Islands based upon the most recent information.

At present, the Soviet Union, the United States, and Canada are all vitally interested in Arctic oceanography and all have made significant contributions to the study of the waters bordering northern Canada. Most recent hydrographic information indicates that there are relatively deep channels extending between the islands from both Baffin Bay and the Arctic Ocean and that the limiting depth through Barrow Strait is about 100 fathoms.

The analysis of sea ice conditions in the Arctic Archipelago is based upon records of the Canadian Dept. of Transport and the U.S. Hydrographic Office. The map of average Sept. ice conditions shows that open water may be expected in Lancaster Sound with light ice concentration in the connecting channels. In the western Arctic open water conditions only occur along the mainland coast.

The discussion of average conditions of temperature and salinity is amplified by diagrams constructed from the results of recent oceanographic cruises. Regional comparisons of eastern and western conditions show that there is a similarity in temperature and salinity above 180 m., while below this depth there appears to be a uniform difference in temperature and salinity. In the western extremity to M'Clure Strait, temperature and salinity range from 0.0°C. and 29.50‰ at the surface to 0.4°C. and 34.93‰ at the bottom. In eastern Lancaster Sound, by comparison, the summer average of temperature and salinity at the surface is 1.0°C. and 31.70‰, and at the bottom, 0.5°C. and 34.50‰.

Temperature-salinity curves show the regional variation in the surface layers and illustrate the similarity of deep water characteristics in Baffin Bay to those at the 250-m. level in the Arctic Basin.

In summer dissolved O concentration varies from 10.0 ml./l. at the surface to a minimum of 7.0 ml./l. at 300 m.

Recent transport calculations indicate that the total eastward transport from the Arctic Ocean through the Canadian Archipelago is of the order of 40,000 km.^{3} per year.--Auth.

3-787. Robitaille, Benoît. GÉOMORPHOLOGIE DU SUD-EST DE L'ÎLE CORNWALLIS, TERRITOIRES DU NORD-OUEST [Geomorphology of Southwest Cornwallis Island, Northwest Territories]: Cahiers de Géographie de Québec, v. 4, no. 8, p. 359-365, map, Apr.-Sept. 1960.

Describes the morphology of the southwestern part of Cornwallis Island and its main geological and structural features. Folded Paleozoic sediments became peneplaned. During the Pliocene, upheaval and erosion of the main valleys took place. Two different types of glaciation took place during the Pleistocene, one consisting of a regional ice cap, the other with ice tongues and glaciers flowing through the valleys. In postglacial times eustatic movements took place and raised beaches were formed. The climatic conditions in our days and the almost total absence of vegetation determine the present erosion and degradation. This takes place alternately by running water during short periods and by frost action which strongly fractures the rocks. Solifluction is also very active.--C. Voûte.

3-788. Hamelin, Louis Edmond. LA COMMISSION DU PÉRIGLACIAIRE AU MAROC EN 1959 [The Periglacial Commission in Morocco in 1959]: Cahiers de Géographie de Québec, v. 4, no. 7, p. 212-217, illus., Oct. 1959-March 1960, 6 refs.

A short account of the principal geomorphological features observed during a 10-day excursion in the central Moyen Atlas, the Haut Atlas, and the Rif. The landscape has undergone the influence of alternating pluvials and dry periods. Pluvial periods in the lower regions correspond to periglacial and even some glacial features in the higher parts of the mountains.--C. Voûte.

3. STRUCTURAL GEOLOGY

See also: Geologic Maps 3-721, 3-738, 3-739; Areal and Regional Geology 3-749, 3-752; Geophysics 3-847, 3-856, 3-857, 3-858, 3-863, 3-865; Geochemistry 3-874; Fuels 3-975, 3-987.

3-789. Kelley, Vincent C., and N. James Clinton. FRACTURE SYSTEMS AND TECTONIC ELEMENTS OF THE COLORADO PLATEAU: New Mexico, Univ., Pubs. in Geology, no. 6, 104 p., 9 maps (3 under separate cover incl. tectonic map, scale 1 in. to 8 mi.), 25 pls., 1960, 92 refs.

Regional fracture systems were mapped for an area of about 90,000 sq. mi., embracing most of the Colorado Plateau and small strips of the adjoining Rocky Mountains, by the use of aerial photographs and mosaics. Not included in the study, however, are most of the Uinta and Piceance basins and the Grand Canyon section from the Kaibab uplift westward. The data interpreted from the photographs were plotted on acetate overlays and these were photographically reduced to produce the final map.

The regional fracture systems are described and discussed under 35 tectonic divisions. Under each tectonic heading a brief sketch of the structural geology and rocks in which fractures occur is given as a setting for description and discussion of the fracture systems. The tectonic map on which these divisions are shown includes an index of anticlines, faults, and igneous centers.

Joints range greatly in persistency, from those that are confined to a single bed to those that continue through the thick sequence of beds. Joints are commonly of different frequency and orientation in adjacent beds. In some areas the joints may be restricted to one set, whereas in other areas there are several sets in a single system of joints. In general, weak rocks such as mudstone are much more jointed than strong rocks such as massive sandstone.

Joints are nearly as numerous in young rocks as in old ones, and it appears that many joint sets in the older formations may be old. Thus, after a few sets of joints are formed, new ones are not so likely to form. Dominant joints are nearly vertical in areas of low-dipping or little-folded rocks, but inclined longitudinal and oblique joint sets are common along monoclinal flexes. From this relationship and from the fact that the fracture systems show no decipherable relationship to folds in many places, it is concluded that many of the joint sets are older than the principal Laramide deformation and were nearly vertical before Laramide tilting. Some, however, are clearly younger than the principal Laramide folding.

It is concluded that the fractures are of many ages and that their origins are several. For a few of the major uplifts the over-all fracture pattern reveals some similarity of arrangement, but for most of the tectonic elements the fracture systems are rather dissimilar and commonly lack relationship to the structural forms. The lack of regularity in orientation and prominence of joint sets on the major uplifts is due to 1) differences in the regional setting of the uplifts; 2) differences in their forms; 3) differences in the bedding, fluid content, and relative strength of the rocks involved; and 4) differences in their rates and manner of growth. For these reasons the fracture patterns of the uplifts are largely unique.

Numerous joints probably formed early for reasons such as differential compaction, differential loading, mass movement in the direction of original dip, and by epeirogenic warping. Nevertheless, the existence of some consistency of orientation in the dominant regional sets in northeasterly, northwesterly, and easterly directions makes it appear that there was some over-all deep-seated stress system that was generally responsible for the final gross features of the fracture pattern.

Three E.-W. lineaments of fracture zones, the Cache Valley, Rico, and Rattlesnake, are thought to be reflections of shear zones in the basement which may have been active before and during Laramide deformation.

Two phases of Laramide deformation on the plateau are postulated. The first resulted from a principal regional stress oriented easterly to southeasterly which formed the northeasterly and northerly trending monoclines. The second resulted from a principal regional stress oriented northeasterly which formed the northwesterly trending folds and uplifts.--Auth.

3-790. Millman, Peter M., and others. THE BRENT CRATER: Canada, Dominion Observatory, Pub., v. 24, no. 1, p. 1-43, 25 figs., incl. illus., maps, graphs, 3 tables, 1960, 21 refs.

The feature known as Brent Crater, located in Algonquin park, Ontario, was first observed on aerial photographs as a circular depression approximately 2 mi. in diameter. Geological investigations indicated that the circular area was underlain by Paleozoic sediments while the surrounding country rock was mainly granite gneiss. Magnetic investigations led to the conclusion that the crater was filled with material of lower magnetic susceptibility than the surrounding rock. Seismic observations indicated that the crater contained up to 1,000 ft. of fairly soft rocks, and perhaps 3,000 ft. of other material in which seismic waves travelled more slowly than in the surrounding gneiss. Gravity observations showed that the crater was filled with material of relatively low density to a depth of from 1,500 to 4,000 ft. depending upon assumptions concerning the average density contrast. A diamond drill hole near the center penetrated to a depth of 570 ft. of Paleozoic sediments, while a second hole near the edge revealed the presence of large quantities of rock breccia. It was concluded that the crater was formed by the impact of a meteorite, possibly in late Precambrian time, and that its present state was a consequence of subsequent erosion and the deposition within it of Paleozoic sediments.--Auth.

3-791. Lustig, E.N. THE ENERGY CONSUMED IN THE FORMATION OF THE EARTH'S CRUST: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 269-273, 3 figs., 22 refs.

In the process of the crust's formation produced by the differentiation of the earth's mantle, energy of an average order of 10^{26} erg/year is released. If our evaluation of the energy of tectonic processes computed on the basis of the energy of seismic waves is correct, then, under certain conditions the amount of the released energy may be sufficient for sustaining these processes. From this viewpoint, the most logical scheme would be one based on the assumption that sial rises from the mantle along a planetary fracture.--Auth.

3-792. Thorsteinsson, R., and E.T. Tozer. SUMMARY ACCOUNT OF STRUCTURAL HISTORY OF THE CANADIAN ARCTIC ARCHIPELAGO SINCE PRECAMBRIAN TIME: Canada, Geol. Survey, Paper 60-7, 25 p., 3 maps (2 in pocket), sec., 1960, 50 refs.

The archipelago is comprised of 7 structural provinces: 1) a probable Tertiary volcanic province; 2) Precambrian Shield; 3) Arctic lowlands; 4) Franklinian geosyncline, an area of pronounced subsidence between Cambrian and Devonian times; 5) Sverdrup basin, centered on the Ringnes Islands and central Axel Heiberg Island and filled with Pennsylvanian to early Tertiary deposits; 6) Prince Patrick uplift, an inlier of Devonian rocks characterized by N.-trending Tertiary normal faults; 7) Arctic Coastal Plain on the W. and NW. edge of the archipelago, composed of nearly undisturbed late Tertiary or Pleistocene sediments.

Early Paleozoic (late Silurian or early Devonian) movements produced N.-trending folds on Cornwallis and Eastern Bathurst islands and probably also the Grinnell Peninsula. Mid-Paleozoic movements affected the remainder of the miogeosyncline and produced the Parry Island fold belt. Tertiary folding and thrusting has produced northerly to northeasterly trending structures on Ellesmere and Axel Heiberg islands. Diapiric intrusions of Permo-Pennsylvanian evaporites were emplaced in Tertiary time along the axle part of the Sverdrup basin, from Sabine Peninsula, through Ringnes Islands, across Axel Heiberg Island to northwestern Ellesmere Island.

Normal faults, probably later than the Tertiary folds are widespread in the Queen Elizabeth Islands, particularly in the region of the Prince Patrick uplift. Relatively recent faulting has probably taken place. This is shown by the presence of probable faults displacing beds on the Arctic Coastal Plain and the many straight and arcuate coastal cliffs that are probably fault, or fault-line scarps.--M. Stewart.

3-793. Zamarenov, A.K., and others. THE SOUTHEAST FRAME OF THE NORTHERN PRI-CASPIAN AREA: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-A, p. 27-33, 4 maps, 1959, pub. 1960, 14 refs.

The principal structures are described of the northern Ustyurt plateau, U.S.S.R., which forms the SE. boundary area of the northern Pri-Caspian salt dome district. The main data used have been provided by seismic surveys. Subsurface structures are expressed in the Mesozoic and Tertiary sequences by gentle folds, angular unconformities, or a considerable decrease in thickness of stratigraphic units. The structural plan for the deeper horizons is more complicated and displays probable fault zones as well. The main uplifts represent inherited folds which form the southwestward continuation of one of the branches of the Uralian-Hercynian structures. This branch fades out in the area described. In the northern part of the Ustyurt plateau 2 fold structures of Ural and Asiatic trend join, accounting for the tectonic complexity.--C. Voûte.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-744 through 3-747, 3-767, 3-770, 3-773, 3-774; Paleontology 3-811, 3-812; Mineral Deposits 3-962; Fuels 3-993.

3-794. Levorsen, A.I. PALEOGEOLOGIC MAPS: 174 p., maps, secs., diags., San Francisco, W.H. Freeman, 1960, 61 refs.

A paleogeologic map of a surface of unconformity represents a break or hiatus in the continuity of the geologic story, a point that frequently marks the end of one natural episode and the beginning of another, and as such is a key place for study. A paleogeologic map lends itself to much the same interpretation as does a geologic map of a present surface.

This book demonstrates how paleogeologic maps may be used by students and practicing geologists interested in the history of sedimentary rock sequences. It shows how such maps are prepared and explains some of the interpretations that may be made from them. A paleogeologic map is another tool that the geologist can use to gain a better understanding of some of the episodes in the geologic history of an area.

All of the maps used as a basis for discussion in this book are from the literature and are available in most geology libraries. Useful paleogeologic maps can be made of nearly any area where sediments and unconformities occur. The examples used were chosen because they present some special element of interpretation or evidence, or permit reasoning that may be applied to other areas as well. --From pref.

Contents: introduction; sources of data - preparation and interpretation of paleogeologic maps; uses of paleogeologic maps; oil fields; regional areas; continental areas.

3-795. Kosanke, Robert M., and others. CLASSIFICATION OF THE PENNSYLVANIAN STRATA OF ILLINOIS: Illinois State Geol. Survey, Rept. Inv. 214, 84 p., 4 figs. incl. secs., pl. (in pocket), 3 tables, 1960, 126 refs.

A new rock-stratigraphic classification of Pennsylvanian strata of Illinois is presented in conformity with the multiple stratigraphic classification system recently adopted by the Illinois State Geological Survey. The nearly 3,000 ft. of Pennsylvanian strata have been classified into formations based on gross variations in average composition or in relative abundance of distinctive lithologic types. The following 3 groups and 7 formations are recognized.

	Maximum thickness (ft.)
McLeansboro group	
Mattoon formation	600+
Bond formation	300+
Modesto formation	400
Kewanee group	
Carbondale formation	400
Spoon formation	350
McCormick group	
Abbott formation	350
Caseyville formation	500

The Pennsylvanian sequence consists of several hundred individual lithologic units - sandstone, shale, clay, limestone, and coal - few of which are thick enough to be considered formations. About 130 of the individual units have been named and are recognized as members.

The gross characteristics used to differentiate the formations generally cannot be determined from individual exposures. Consequently, identification of a formation depends on recognition of a characteristic member within the exposure, or on determination of the relation of the exposure to selected widespread members that are the bounding units of the formations.

The revised classification replaces one that did not recognize formations. In the previous classification 4 groups were divided into about 50 cyclothems based on the cyclical repetition of the various rock types. Because the cyclical units have not proved useful in economic studies and have not been widely used in mapping, they have not made satisfactory units for rock-stratigraphic classification. However, as they are particularly useful in geologic interpretation they are retained in a separate cyclical classification.

The practice of applying the same geographic name to several closely associated members is eliminated, and new names have been presented where necessary. Although an effort has been made to extend one name to all equivalent strata in various parts of the state, local names are retained in some areas. A chart shows a composite section of the Pennsylvanian strata in Illinois, all the names accepted in Illinois for the rock units and cyclothems, and correlations with units in Indiana, western Kentucky, and Missouri. Descriptions of the type sections of the formations, a table of type localities of all named members, and a list of type localities of named cyclothems are included.--Auth.

3-796. Hite, Robert J. STRATIGRAPHY OF THE SALINE FACIES OF THE PARADOX MEMBER OF THE HERMOSA FORMATION OF SOUTHEASTERN UTAH AND SOUTHWESTERN COLORADO: U.S. Geol. Survey, Repts., Open-File Ser., no. 590, 15 p., 2 figs. (in pocket), table, [1960], 16 refs.

The "saline facies" of the Paradox member [Pennsylvanian] is made up of a stratigraphic sequence of at least 29 evaporite cyclothems, containing thin beds of black shale. The sequence is readily amenable to a system of nomenclature which can be used over most of the Paradox salt basin.

Mapping of individual salt beds within the "saline facies" has shown that surface features within the Paradox salt basin, described as salt anticlines, were actually sedimentary troughs during most of the time of salt deposition. Many of the oldest salt beds deposited in these troughs thin out over adjacent highs.

Isopachous maps of several of the salt beds within the "saline facies" illustrate that for certain periods of chemical sedimentation the basin axis radically shifted from E. to W.

Numerous occurrences of oil and gas have been discovered by wells in the "saline facies." These occurrences, which often cause high pressure "blowouts," have been found in both the salt beds and in the intervening clastic-sulfate units. Structural conditions may have been a determinant in developing favorable permeabilities in otherwise very tight reservoir rocks. The areal distribution of each evaporite cyclothem is directly significant to petroleum exploration. The limestone facies of each cyclothem may contain organic buildups similar to those in the oil and gas fields on the SW. shelf of the evaporite basin.--Auth. summ.

3-797. Pugh, Derek C. THE SUBSURFACE GETHING AND BLUESKY FORMATIONS OF NORTHEASTERN BRITISH COLUMBIA: Canada, Geol. Survey, Paper 60-1, 20 p., 4 maps (in pocket), 2 secs. (in pocket), 2 tables, 1960, 12 refs.

Preliminary account of a stratigraphic study of the formations in the area deduced from drill core evidence. Generalized stratigraphic succession as follows: Cadomin conglomerate and cherty sandstone, Gething marine strata and coal, overlain by a disconformity and the Bluesky chert and glauconitic quartzose sandstone, plus the Moosebar shales. All are of Lower Cretaceous age. The Gething and Bluesky formations are described in detail.

Structurally the beds are elevated in the foothills belt and are associated with much thrust faulting. There are few reported gas or oil shows in the Gething formation in northeastern British Columbia, as the Gething sands are generally silty and dense. The Bluesky formation, however, seems to have more commerical possibilities. There are widely scattered discoveries, since the porous Bluesky beds are sealed below and above by dense strata. An appendix gives a detailed description of the drilling samples, stating their location and elevation.--M. Stewart.

3-798. Brodsky, Harold. THE MESAVERDE GROUP AT SUNNYSIDE, UTAH: U.S. Geol. Survey, Repts., Open-File Ser., no. 595, 70 p., 16 illus., map, diag., 2 pls. (4 sheets, 3 in pocket), 1960, 34 refs.

The Mesaverde group of Late Cretaceous age at Sunnyside, Utah, consists of, in ascending order: the Blackhawk formation, Castlegate sandstone, and the Price River formation. The Mancos shale intertongues with the Blackhawk formation.

The Mancos shale formed in an offshore marine environment, the Blackhawk formation formed in a mixed marine and continental environment, and the Castlegate and Price River formations at Sunnyside, Utah formed in a continental environment.

Thin even bedding characterizes the Mancos shale except where it extends as a thin tongue into the Blackhawk formation. Tongues of the Mancos shale in the Blackhawk formation have in places disrupted bedding and locally contain impressions of twigs and branches. Disrupted bedding with mottling, irregular and uneven bedding, and very thick bedding with cross stratification resembling lower foreshore laminae, are primary structures common in modern marine sediments and can also be found in the marine tongues of the Blackhawk formation. Massive, wedge-shaped, cut-and-fill structures characteristic of fluviatile deposits are found in the Castlegate-Price River formations.

Particle size distribution in the marine tongues of the Blackhawk formation shows an increasing coarseness as shoreline deposits are approached. Coal particles are generally absent in the marine sandstones of the Blackhawk formation but are commonly found in abundance in the continental sandstones in the Blackhawk.

The economic coal beds within the Blackhawk formation at Sunnyside have been reported as consisting of a "lower" Sunnyside seam and an "upper" Sunnyside seam. Stratigraphic sections and drill logs indicate that these seams may be splits of one major coal bed and that the term "upper" Sunnyside seam refers to more than one major split.

The relationship of the splits in the Sunnyside coal seams and the lithologic characteristics of the coal indicate that the coal swamp existed on a low-lying coastal plain close to sea level where swamp accumulations were interrupted occasionally by fluviatile deposition.

Subsidence due to compaction of underlying sediments, aggradation as the shoreline regressed as well as slow tectonic subsidence or gradual eustatic rise in sea level are factors which may account for the thickness of the Sunnyside coal beds.--Auth.

3-799. Smith, Merritt B., comp. BASEMENT WELLS IN CALIFORNIA AND NEVADA: U.S. Geol. Survey, Repts., Open-File Ser., no. 566, 130 p., Dec. 1959.

Basement rocks in California include igneous and metamorphic rocks of Mesozoic and older age; also certain indurated, sheared, and slightly metamorphosed sedimentary rocks, isolated occurrences of younger intrusive rocks, and extrusive rocks lying on the previously listed basement rocks. In the Basin and Range province in eastern California, only Precambrian rocks and larger bodies of later intrusive and metamorphic rocks are considered basement. Elsewhere in the state, basement rocks include sedimentary rocks of Mesozoic and older age, except the Upper Jurassic Knoxville formation and overlying Cretaceous sedimentary rocks heretofore considered post-Franciscan. In particular, the Franciscan formation is referred to basement, as are subsurface rocks in the Santa Maria basin assigned to the undifferentiated Knoxville and Franciscan formations by Woodring and Bramlette, and Dibblee.--Auth.

This tabulation lists about 2,500 wells in California and 1 in Nevada, giving locations and elevations of wells and depths to basement.

5. PALEONTOLOGY

See also: Geomorphology 3-777.

3-800. International Symposium on the Origin of Life on the Earth, 1st, Moscow, 1957. PROCEEDINGS... Edited for the Academy of Sciences of the U.S.S.R., by A.I. Oparin, A.G. Pasynsky, A.E. Braunshtein, T.E. Pavlovskaya. English-French-German edition, edited for the International Union of Biochemistry, by F. Clark and R.L.M. Synge: 691 p., illus., map, diags., graphs, tables, New York, Pergamon Press, 1959, refs.

The first session (p. 9-119) contains 9 papers on primary formation of primitive organic compounds on the earth. They are as follows:

Fesenkov, V.G. Some Considerations About the Primaeval State of the Earth.
Urey, H.C. Primitive Planetary Atmospheres and the Origin of Life.
Vinogradov, A.P. The Origin of the Biosphere.
Bernal, J.D. The Problem of Stages in Biopoesis.
Sokolov, V.A. The Evolution of the Atmosphere of the Earth.
Levin, B. Yu. The Formation of the Earth from Cold Material and the Problem of the Formation of the Simplest Organic Substances.
Pirie, N.W. Chemical Diversity and the Origins of Life.
Kropotkin, P.N. The Geological Conditions for the Appearance of Life on the Earth and the Problems of Petroleum Genesis.
Terentev, A.P., and E.I. Klabunovsky. The Role of Dissymmetry in the Origin of Living Material.

The other 6 sessions deal with the transformation of primary organic compounds on the earth; origin of proteins, nucleoproteins, and enzymes; origin of structure and metabolism; evolution of metabolism.

3-801. Myers, George S. THE ENDEMIC FISH FAUNA OF LAKE LANAO AND THE EVOLUTION OF HIGHER TAXONOMIC CATEGORIES: Evolution, v. 14, no. 3, p. 323-333, Sept. 1960, 40 refs.

The origin of Lake Lanao, on Mindanao Island (Philippines), can be attributed to volcanic activity in a relatively very recent part of the Quaternary. Nevertheless a single cyprinid species (Barbus binotatus) gave rise to the present fish fauna consisting of at least 18 species including 4 new genera. A comparison with many other fresh-water lakes all over the world shows that the explosive evolutionary pattern is similar to that of island faunas and of any groups newly admitted to extensive areas where competition is light or absent. This type of evolution is important for the origin of higher systematic categories.--C. Voûte.

3-802. Simonetta, Alberto M. ON THE MECHANICAL IMPLICATIONS OF THE AVIAN SKULL AND THEIR BEARING ON THE EVOLUTION AND CLASSIFICATION OF BIRDS: Quart. Rev. Biology, v. 35, no. 3, p. 206-220, illus., Sept. 1960, 23 refs.

Many birds can raise the upper jaw as well as depress the lower. These are called kinetic forms. Kineticism is general in most vertebrates, metakinetic forms in which there is a flexure behind the parietals being primitive. Snakes are mesokinetic, with the flexure just in front of or just behind the frontals. Amphikinetic forms have both types of joints. Study of Mesozoic birds strongly suggests the absence of any such joint in Archaeopteryx. Hesperornis increased its gape through a joint between the angular and splenial. The paleognathous birds are either akinetic or weakly kinetic. Three distinct kinetic types have developed in the neognathes.

It is suggested that studies of this type may be able to shed considerable light on the pattern of bird evolution.--A.E. Wood.

3-803. van Valen, Leigh. THERAPSIDS AS MAMMALS: Evolution, v. 14, no. 3, p. 304-313, Sept. 1960, 69 refs.

On theoretical considerations it is proposed to adopt adaptive differences instead of criteria of the jaw-ear structure for separation of the classes of Reptilia and of Mammalia. Using as main adaptive features care for the young and reproduction, intelligence and activity it is reasoned that the therapsids should be classified with the mammals and no longer with the Reptilia. Most of the evidence brought forward has to be of an indirect and speculative nature. --C. Voûte.

3-804. Reed, Charles A. POLYPHYLETIC OR MONOPHYLETIC ANCESTRY OF MAMMALS, OR: WHAT IS CLASS?: Evolution, v. 14, no. 3, p. 314-322, diag., Sept. 1960, 9 refs.

Discusses the philosophy and logics of zoological classification. Mammals can be defined either as an evolutionary unit descending from a single ancestor, in which case the Therapsida and part of the Pelicosaura belong to the Mammalia, or as a group which has acquired certain characteristics in common as a result of evolutionary improvement. The common definition of the mammals on the basis of details of the lower jaw-middle ear, which belongs to the second system of classification, can only partially express phylogeny, will inevitably result in polyphyletic patterns, and is in disagreement with the current taxonomic terminology based on monophyletic units.--C. Voûte.

3-805. Simpson, George Gaylord. DIAGNOSIS OF THE CLASSES REPTILIA AND MAMMALIA: Evolution, v. 14, no. 3, p. 388-392, Sept. 1960, 10 refs.

A short critical comment on the classification and definition of the Mammalia proposed by L. van Valen, and C.A. Reed (see abstract above). From a theoretical and philosophical point of view the ideas expressed have several shortcomings, moreover they are difficult to apply in actual classification work.--C. Voûte.

3-806. Clarke, Arthur H., Jr. CATALOGUE AND ILLUSTRATIONS OF MOLLUSKS DESCRIBED BY WESLEY NEWCOMB, WITH A BIOGRAPHICAL RESUME: Bulls. Am. Paleontology, v. 41, no. 188, p. 135-160, port., pl., 1960, 12 refs.

Wesley Newcomb, M.D. (1808-1892), conchologist and traveler, described 126 species of mollusks (mostly species of Achatinella and Helix) in 21 papers published between 1853 and 1874. In 1868 his large private collection, containing most of his types, was purchased for Cornell University where it remains today. Although most of Newcomb's species are still considered good, several, which are here figured for the first time, have not been clearly understood.--Auth.

3-807. Browne, Ruth G., and Donald E. McDonald. WISCONSIN MOLLUSCAN FAUNAS FROM JEFFERSON COUNTY, KENTUCKY: Bulls. Am. Paleontology, v. 41, no. 189, p. 165-183, map, secs., 5 pls., 1960, 16 refs.

Molluscan faunas of Wisconsin age are the first described from Jefferson County. Loess and water-laid silts from the Tazewell substage yielded 25 species representing 8 families and 18 genera.

From deductions based on the ecological requirements of the extralimital species it is concluded that the annual mean temperature was lower than at present, the region was provided with permanent water bodies, and the territory was wooded.

The location of the region just beyond the terminus of the Wisconsin ice sheet explains the cool climate as well as accounting for the water bodies either as meltwater streams issuing from the glacier or as proglacial lakes formed by damming of existing streams.

The ice sheet also provided the source material of the sediments as active outwash without protective cover of continuous vegetation.--Auth.

3-808. Hubricht, Leslie. HENDERSONIA OCCULTA FOSSIL IN MISSISSIPPI: Nautilus, v. 74, no. 2, p. 83, Oct. 1960.

Among 18 molluscan species recorded from a loess deposit 1 mi. E. of Yazoo City is Hendersonia occulta (Say), a gastropod previously unreported living or fossil S. of Tennessee.--J.W. Valentine.

3-809. ART OF AMERICAS FROM 30,000 B.C.: Life, v. 49, no. 7, p. 86, illus., Aug. 15, 1960.

A 6 in. pelvis fragment, thought to be from an "elephant," and preliminarily dated as 30,000 years old (presumably by radiocarbon methods but not so stated) bears crudely scratched outlines of animals interpreted to represent mastodons or mammoths, tapir, and bison. The fragment was excavated from the desert near Valsequillo, Mexico, by Juan Armenta Camacho of the University of Puebla. It is considered possible that this may be the oldest human artifact yet found in the Western Hemisphere.--J.A. Dorr, Jr.

3-810. Cole, W. Storrs. THE GENUS CAMERINA: Bulls. Am. Paleontology, v. 41, no. 190, p. 190-205, 4 pls., 1960, 19 refs.

The internal structure of representative specimens of the several genera which have been recognized for camerinids with undivided chambers is reviewed. The conclusion is reached that the only valid genera which can be distinguished by internal structure are Camerina and Miscellanea. The other assumed genera have been based on superficial and intergrading differences in form which are individual and specific, not generic, characters. Miscellanea seemingly is confined to the Paleocene, but Camerina, which may be subdivided in several form lineages, extends from Paleocene to Recent.--Auth.

3-811. Wall, J.H. UPPER CRETACEOUS FORAMINIFERA FROM THE SMOKY RIVER AREA, ALBERTA: Research Council Alberta, Geol. Div., Bull. 6, 43 p., fig., chart, 5 pls., table, 1960, 30 refs.

Nineteen species and subspecies of Foraminifera - one of which is proposed as new - from the upper part of the Kaskapau shale and the lower part of the

Puskwaskau shale in the Smoky River area of Alberta, western Canada, are figured and described. The problem of stratigraphic nomenclature within the Smoky River group is reviewed, and a new formational name, Puskwaskau, introduced to designate the shales lying between the Bad Heart sandstone and the Wapiti formation in the Smoky River area. Brief descriptions of the lithology encountered at the 2 collecting localities on the Smoky and Bad Heart rivers are given.

Although little change in the general aspect of the microfaunas from the Kaskapau and Puskwaskau shales is noted, a few apparently diagnostic species from each shale unit are listed. The microfaunas are dated Coniacian-Santonian by their association with ammonites of the Scaphites ventricosus, Scaphites depressus, and Clioscaphites vermiformis zones. The white-speckled, calcareous shale "zone" in the Puskwaskau shale is considered the partial equivalent of the first or upper white-speckled shale "zone" occurring at or near the top of the Colorado shale in other areas of Alberta and northern Montana. The microfauna associated with this "zone" carries elements common to both the Boyne member of the Vermilion River formation of Manitoba and the Niobrara formation of the Central Plains region of the United States.

The foraminiferal assemblages are dominantly arenaceous. The depth of the water appears to have been quite shallow, but deepened considerably at the time of the deposition of the white-speckled shale as revealed by the associated calcareous, pelagic Foraminifera.--Auth.

3-812. Sabol, Joseph W. THE MICROFAUNA OF THE YORKTOWN FORMATION FROM JAMES RIVER, SURRY COUNTY, VIRGINIA: Bulls. Am. Paleontology, v. 41, no. 191, p. 211-246, 4 figs. incl. map, pl., 1960, 83 refs.

Foraminifera, Ostracoda, and Mollusca from the Yorktown formation (upper Miocene) of the Cobhams Wharf area are listed, described, and discussed. Twenty-five forms of Foraminifera and 15 forms of Ostracoda are compared stratigraphically and ecologically with other localities of the Yorktown formation on the York-James Peninsula. The validity of Mansfield's zonation of the Yorktown is discussed on the basis of present micropaleontological data. Results show that Mansfield's 'zones' are not valid and that the Foraminifera-Ostracoda fauna of the Yorktown formation is related to the Ecphora-Cancellaria facies of the Choctawhatchee formation of Florida. The problem and status of the genus Bucella and Lagena are discussed. It seems that the Yorktown sea was a shifting one with a depth of about 25 m. at the Cobhams Wharf area. This report supplements the work done on the Yorktown formation in the York-James Peninsula by McLean.--Auth.

3-813. Anderson, Roger Y. CRETACEOUS-TERTIARY PALYNOLOGY, EASTERN SIDE OF THE SAN JUAN BASIN, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Mem. 6, 59 p., fig., 11 pls., 3 tables, 1960, 69 refs.

Pollen and spore florules tend to confirm a Tertiary age for the Ojo Alamo sandstone and Nacimiento formation, a late Cretaceous age for the Kirtland shale, and reflect the environmental changes accompanying local uplift at the Cretaceous-Tertiary transition. Many podocarpaceous and ulmaceous pollen first appear at the base of the Ojo Alamo sandstone, but this basal florule has only 4 forms in common with overlying Paleocene or underlying Cretaceous florules. A florule in the middle of the Ojo Alamo sandstone, however, has 9 forms in common with overlying Nacimiento florules.

Proteaceous grains and Tilia are the dominant dicotyledonous types in the Kirtland shale with conifers absent. The basal florule of the Ojo Alamo sandstone contains more than 70% Podocarpus pollen, ulmaceous pollen, and several other proable upland types. Florules form the middle Ojo Alamo and basal and lower Nacimiento formation contain mixtures of probable upland and lowland forms, with ulmaceous pollen Momipites and Cupaniedites the most persistent dicotyledonous types.

Eight new genera, Bombacacipites, Brevicolporites, Confertisulcites, Intertriletes, Kurtzipites, Navisulcites, Rectosulcites, and Ulmoideipites, are established. Of the 88 fossil descriptions, 39 are new species and 4 are descriptions of dinoflagellates and marine microfossils incertae sedis.--Auth. and F.E. Kottlowski.

3-814. Matthews, William H., III. TEXAS FOSSILS: AN AMATEUR COLLECTOR'S HANDBOOK: Texas, Univ., Bur. Econ. Geology, Guidebook 2, 123 p., 26 figs., 49 pls., Nov. 1960, refs.

In the first part of the paper the term "fossil" is defined, and the 4 main divisions of paleontology are explained. The different kinds of fossil preservation are described and illustrated by photographs. Several following sections discuss where and how to collect fossils and how to prepare, identify, and catalog specimens. A diagrammatic key based on symmetry is included and will be useful to the beginning collector.

A brief introduction to the geologic column is followed by a resumé of the physiography and geology of Texas which includes a generalized geologic map in color.

The main kinds of fossils are discussed systematically, beginning with plants and followed by invertebrates and vertebrate animals. The plants are discussed only briefly. The general characters of the classes and orders of the invertebrates and vertebrates are described in more detail. The geologic range and the occurrence in Texas are noted for each fossil group.

Numerous line drawings illustrate morphologic features. Common Texas examples of fossil plants and invertebrates and restorations of fossil vertebrates are described in the text. A list of books about fossils, a glossary, and a comprehensive index complete the paper.--P. U. Rodda.

6. GEOPHYSICS

See also: Geologic Maps 3-676 through 3-715; Areal and Regional Geology 3-771; Structural Geology 3-790.

3-815. Joyce, J. Wallace. THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS: Am. Geophys. Union, Trans., v. 41, no. 1, p. 22-25, March 1960.

The International Union of Geodesy and Geophysics were founded in 1919 as a member of the International Research Council, which in 1931 was replaced by the International Council of Scientific Unions. Its purpose is to coordinate research on problems of geodesy and geophysics requiring international cooperation or having international interest. It has 7 more or less autonomous associations: Geodesy, Seismology and Physics of the Earth's Interior, Meterology and Atmospheric Physics, Geomagnetism and Aeronomy, Physical Oceanography, Volcanology, and Scientific Hydrology. The Union's functions are carried out by the General Assembly, the Council which consists of the Bureau of the principal delegates of the adhering countries, the Executive Committee which coordinates the interests of the associations, and the Bureau which carries on the normal business of the Union between General Assemblies. At present 54 countries adhere to the IUGG through a scientific institution or governmental agency. In the United States, the National Academy of Sciences is the adhering body; the American Geophysical Union was created as the U.S. National Committee. Countries pay dues on a sliding scale; the present annual income is $43,000, to which UNESCO adds $16,000 for symposia and publications. In 1956 various permanent services were brought together by ICSU in a Federation of Permanent Services of Astronomical and Geophysical Sciences. IUGG alone or jointly with other unions operates permanent services such as those concerning international time, geomagnetic indices, gravimetry, seismology, ultraviolet measurements, atmospheric ozone, and solar activity. The Union and its associations have many programs; a special kind was the participation in such programs as the Second Polar Year, 1932-1933, and the International Geophysical Year, 1957-1958. They publish scientific series, data compilations, transactions of Union and association meetings, and the IUGG Chronicle.--A.C. Mason.

3-816. Salikhov, A.G., and V.P. Stepanov. **DENSITY AND GRAVITATIONAL EFFECT OF PALEOZOIC ROCKS IN THE TATAR REPUBLIC: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 180-184, 2 maps, sec., diag., 2 tables, 4 refs.**

The authors set forth new information on density variations of Paleozoic rocks in the Tatar A.S.S.R., both laterally and within the Bondyug and Elabuga Devonian structures. They present data concerning the gravitational effect caused by variations of the density interfaces. The given investigations were undertaken in conjunction with detailed gravimetric surveys in the Tatar republic and adjacent areas.--Auth.

3-817. Vestine, Ernest H. **THE SURVEY OF THE GEOMAGNETIC FIELD IN SPACE: Am. Geophys. Union, Trans., v. 41, no. 1, p. 4-21, 10 maps, diag., 4 tables, March 1960, 21 refs.**

Declination of the compass from geographic N. has been noted since the time of Columbus. Halley made measurements over the Atlantic Ocean in 1698-1699, and von Humboldt in France, Cuba, Mexico, Peru, and the United States shortly after 1800. Gauss measured magnetic intensity in 1832 and developed the theory of spherical harmonic analysis of the field in 1838. Oceanic magnetometer surveys were made by the Galilee, 1905-1908, the nonmagnetic Carnegie from 1909 until it burned in 1929, and by the Russian ship Zarya since 1956.

Secular-change measurements are more accurate taken aboard a nonmagnetic ship, but airborne surveys are more convenient. Airborne survey results have been incorporated in World Magnetic Charts since 1955. The U.S. Navy Hydrographic Office airborne survey Project Magnet is established on a permanent basis to cover most oceans and some land; accuracy under good conditions is to 15 gammas and 0.1° arc.

At the CSAGI (Comité Scientifique Année Géophysique Internationale) meeting in Moscow in July 1958 some members of the Committee on World Magnetic Surveys and Magnetic Charts of the International Association on Geomagnetism and Aeronomy suggested that the proposed world magnetic survey include data from satellite-borne magnetometers, preferably in polar orbit. The Comité International de Géophysique, successor of the CSAGI, has noted the need for supporting work with rockets, including vertical flights.--A.C. Mason.

3-818. Kalashnikov, A.G., and K. Yu. Zybin. **IGY OBSERVATIONS OF THE VECTOR OF HORIZONTAL GEOMAGNETIC FIELD VARIATIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 159-162, 8 figs., ref.**

Three-component fluxmeter registrations of magnetic field variations are analyzed to determine the behavior of the vector of short-period geomagnetic field variations as a function of the time of day and for comparison with the behavior of the electric field vector. The ratios of the electric to the magnetic components are determined as a function of the period of variation.--Auth.

3-819. Grantz, Arthur, and others. **AN AEROMAGNETIC RECONNAISSANCE OF THE COOK INLET AREA, ALASKA: U.S. Geol. Survey, Repts., Open-File Ser., no. 593, 58 p., 4 maps (3 fold.), fold. sec., 4 fold. profiles, 1960, 27 refs.**

Forty-two E.-W. aeromagnetic lines were flown across the Cook Inlet-Susitna lowland between Chelatna Lake and Seldovia at a flight altitude of approximately 2,500 ft. The lines traverse all or part of 5 Mesozoic tectonic elements that dominate the structure of the Cook Inlet area. Each of these tectonic elements, the Alaska Range geosyncline, the Talkeetna geanticline, the Matanuska geosyncline, the Seldovia geanticline, and the Chugach Mountains geosyncline, has a characteristic magnetic pattern.

The aeromagnetic data, compiled as total intensity aeromagnetic profiles, show several significant features which are consistent with the structural grain of the area. A 2-dimensional anomaly was observed near the E. edge of the area on all but the southernmost profiles, where it becomes obscure. Geologic evidence suggests that this feature, the Knik Arm anomaly, is produced by plutonic rocks that have been intruded along the Seldovia geanticline. SE. of this anomaly the profiles are almost flat. This flatness indicates that magnetic rocks are deeply buried in this area, which is underlain by slate and graywacke deposited in the Chugach Mountains geosyncline.

Near the W. shore of Cook Inlet the character of the magnetic profiles changes abruptly. The line of change, called the Moquawkie magnetic contact, indicates a lithologic change trending NE. To the NW. there are many large, steep-gradient anomalies while to the SE. the profiles have gentle gradients. In the N. this inferred contact is correlated with the

Castle Mountain high-angle reverse fault which has been mapped along the N. side of the Matanuska Valley. This fault separates the volcanic and plutonic rocks of the Talkeetna geanticline to the NW. from the sedimentary rocks of the Matanuska geosyncline to the SE. In lower Cook Inlet the Moquawkie magnetic contact joins the Bruin Bay fault. Between these faults the Moquawkie contact marks the position of smaller faults or an unconformity between sedimentary rocks to the SE. resting on, or faulted against, volcanic or plutonic rocks to the NW.

In the NW. part of the Susitna lowland the magnetic profiles are almost flat, and are interpreted to occur over slate and graywacke deposited in the Alaska Range geosyncline. The change to this magnetic pattern from the pattern with steep gradients over the Talkeetna geanticline is abrupt. The line of change is called the Peters Creek magnetic contact.

The aeromagnetic profiles are smoothest; and therefore sedimentary rocks of the Matanuska geosyncline and Shelikof trough are inferred to be thickest, in the area between the Moquawkie contact on the NW. and the Knik Arm anomaly and the W. front of the Kenai Mountains on the SE. It is inferred that the Susitna lowland and most of the Beluga lowland are not underlain by a great thickness of sedimentary rocks. However, sedimentary rocks may be quite thick under part of the Beluga lowland S. of Beluga Lake.--Auth.

3-820. Dianov-Klokov, V.I. AN APPARATUS FOR MEASURING SMALL REMANENT MAGNETISATION OF ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 91-95, 5 figs. incl. illus., diags., 5 refs.

A magnetometer for rocks of low remanent magnetization based on the rock-generator ("spinner") principle is described. The magnetometer has a sensitivity (I_{min}) nearly equal to 5×10^{-8} gauss for a sample 24 X 24 X 24 mm., with a time constant (τ) nearly equal to 1 sec. and a signal-to-noise ratio of 1. The small mass of the sample holder eliminates the necessity for the special modifications which Johnson, Murphy, and Michelson used for compensation of systematic interference. The instrument is thereby simpler and more compact. A more effective rock generator is based on the impulse reception of the signal $\mathcal{E}_g = -w(\partial \phi / \partial t)$, with a duration Δt (proportional to 1/r), where 1 is 1/2 of the edge length of the sample and r is the length of the sample holder. The proposed impulse rock generator is expected to have a signal-to-noise ratio $(r/1)^{\frac{1}{2}}$ times as great as that of the regular spinner. A multipolar stator that is equipped with a corresponding number of identical pairs of coils is also proposed to achieve the same improvement.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-382).

3-821. Brodskaya, S. Yu., and M.A. Grabovsky. ONE OF THE CAUSES OF NON-COINCIDENCE OF VECTOR OF ROCK RESIDUAL MAGNETIZATION WITH DIRECTION OF MAGNETIZING FIELD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 324-327, 4 figs., 2 tables, 17 refs.

The vector of residual magnetization in the investigated stratified anisotropic rocks does not coincide with the direction of the magnetizing field. Independently of how the magnetizing field was directed during the onset of magnetic intensity and at present, the vector of the residual magnetization of stratified rock will approach the plane of stratifications. It will remain in almost the same plane upon temporal variation in the field direction, since the longitudinal component always has the predominant value.

In the case when the magnetizing field is directed almost perpendicularly to the plane of stratifications, the vectors of residual magnetization of individual samples, remaining almost in the plane of the stratum, may be directed in the opposite direction.

The noncoincidence between the vectors $\underline{I}_n$ and $\underline{H}$, caused by the anisotropy of the rock, is stable even in case of magnetization at low temperatures.--Auth. concl.

3-822. Kruglyakova, G.I., and V.V. Kruglyakov. THE INFLUENCE OF THE CHARACTER OF A LAVA FLOW ON THE FORMATION OF REMANENT MAGNETIZATION OF ROCKS: Akad. Nauk SSSR. Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 103-105, table, 4 refs.

The magnitude and direction of remanent magnetization vectors in extrusive rocks are studied with respect to the movement, viscosity, composition, and temperature of the lava, in addition to the topography of the area of extrusion. Magnetization of ferromagnetic elements takes place when the lava loses its mobility prior to its cooling to the Curie point. The magnetization of the lava under such conditions will be oriented in the direction of the earth's magnetic field regardless of the direction in which the lava flowed. If, however, the lava ceases its movement at a temperature lower than the Curie point temperature, then the direction of magnetization of the rock formed will depend on the direction in which the lava flowed and on the characteristics of the flow (laminar, turbulent). The crystals will have been already magnetized and will be oriented according to the direction of the flow or character of the turbulence. In case of a laminar flow, the magnitude of the remanent magnetization vector will correspond to the intensity of the earth's magnetic field at the time of magnetization, but the vector's direction may be different from the earth's magnetic field direction of the time. In case of a turbulent motion, the orientation of magnetic elements in the solidified lava will have a random character.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-408).

3-823. Pospelova, G.A. ORIGIN OF THE REVERSED MAGNETIZATION OF VOLCANIC ROCKS FROM ARMENIA AND THE KURIL ISLANDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 21-28, 10 figs. incl. illus., diags., graphs, 2 tables, 18 refs.

Investigation of volcanic rocks from Armenia and the Kurile Islands showed early Quaternary-upper Pliocene rocks to be magnetized in a direction opposite to the present geomagnetic field. A detailed investigation of the magnetic properties, the stability characteristics, the content of the ferromagnetic fraction, and of the thermo-remanence of directly as well as reversely magnetized samples in the laboratory did not reveal any great differences among them. The origination of the reversed polarity of the rocks can be explained quite justifiably with the reversal of the earth's magnetic field as a whole during early Quaternary-upper Pliocene times.--Auth.

3-824. Mishin, V.M., and O.M. Barsukov. ON THE DIURNAL VARIATION OF EARTH CURRENT DISTURBANCES AS OBSERVED BY SOVIET STATIONS DURING THE IGY: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 96-97, 2 figs., 2 tables, ref.

Fourier harmonic analysis is applied to interpret the diurnal variation rate of telluric currents obtained from hourly values of the tellurogram swing in millivolts per kilometer. It was found that the diurnal magnetic disturbance consists of components that depend upon local and universal time. The fundamental diurnal component of the telluric variation rate was found to consist of 2 terms with approximate midday and midnight maximums; these vary with latitude. It is considered that the first term is due to the dynamo effect in the ionosphere, and that the second is caused by a screening effect of the ionosphere at middle latitudes plus the night maximum of conductivity due to corpuscular intrusions at higher latitudes. An analogous correspondence was found for short period variations (a few seconds to a minute) of the earth's electromagnetic field.--A. J. Shneiderov (courtesy Geophysical Abstracts 181-83).

3-825. Belenky, Ya. E., and others. MULTICHANNEL TELEMETER FOR COMBINED GEOPHYSICAL INVESTIGATION OF WELLS: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 55-59, 2 diags., log, 1959, pub. 1960, 3 refs.

A short technical description of an apparatus for automatic simultaneous recording of several geophysical parameters at one passage of the cable down a borehole, consisting of an in-hole instrument, receiver, input generator, and a photo-recorder. The number of measuring channels is 9, a single KOBD-4 cable being used. Substitutions can be made that permit not only the measuring of apparent resistivity, self-inducted potential, but also temperature, diameter of the hole, and other parameters.--C. Voûte.

3-826. Garland, G.D., and T.F. Webster. STUDIES OF NATURAL ELECTRIC AND MAGNETIC FIELDS: U.S. Natl. Bur. Standards, Jour. Research, v. 64D (Radio Propagation), no. 4, p. 405-408, map, graphs, July-Aug. 1960, 5 refs.

Simultaneous measurements of short-period natural electric field variations across western Canada are reported. From these it is indicated that the effect of the varying depth to the Precambrian rocks is the dominant factor. Analysis of the simultaneous magnetic and electric measurements gives a resistivity for the Precambrian basement in excess of 30×10^5 ohm meters.--Auth.

3-827. Kalashnikov, A.G., and E.N. Mokhova. ON SHORT-PERIOD VARIATIONS OF THE REGIONAL ELECTROMAGNETIC FIELD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 29-31, 6 figs., ref.

A study was made of small-period variations of impulse, train, and microbay types recorded simultaneously over a large area by 4 stations: "Borok" ($\phi = 58^\circ 2'$, $\lambda = 38^\circ 58'$), "Lovozero" ($\phi = 67^\circ 58'$, $\lambda = 35^\circ 5'$), "Petropavlovsk" ($\phi = 53^\circ 6'$, $\lambda = 158^\circ 38'$), and "Dusheti" near Tbilisi ($\phi = 42^\circ 5'$, $\lambda = 44^\circ 42'$) in the U.S.S.R. Data from several American magnetic stations were also analyzed. Assuming that the frequency characteristics of the apparatus at the Russian stations are approximately equal, it was found that the values of H_z of the observed variations are equal at these stations, and that the horizontal component of earth currents at these stations can be given by the expression $E = (E^2_{N-S} + E^2_{E-W})^{1/2}$.

No explanation has been found for these regularities; however, various possibilities have been suggested. --A. J. Shneiderov (courtesy Geophysical Abstracts 181-373).

3-828. Vladimirov, N.P. THE FEASIBILITY OF USING THE EARTH'S NATURAL ELECTROMAGNETIC FIELD FOR GEOLOGICAL SURVEYING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 89-90, 2 figs., 4 refs.

The feasibility of utilization of the short variations (0.3 - 1,000 c.p.s.) of the earth's natural electromagnetic field in geologic exploration is reported. Magnetoelectric oscillograms were made in the Rylsk area of the Kursk region where sand-clay deposits are underlain at the depth of 500 m. by crystalline basement of practically infinite resistivity. The apparent electric resistance ρ_k was determined from the recorded frequencies f, horizontal electric intensity components E_x and E_y, and the variations of the horizontal magnetic components H_y and H_x by the following formulas: $\rho_k = (1/5) f (E_x/H_y)^2$, and $\rho_k = (1/5) f (E_y/H_x)^2$. In spite of relative errors in determination of ρ_k, the calculated depth to basement was found to be $h = (x/8)(10\rho_1) \approx 0.45$ km. as compared to a depth of 0.5 km. determined by other methods.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-192).

3-829. Parkhomenko, E.I., and A.T. Bondarenko. EFFECT OF UNILATERAL PRESSURE UPON ELECTRICAL RESISTANCE OF ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 214-219, 8 figs., 2 tables, 11 refs.

The effect of unilateral compression stress on the electrical resistivity of samples of sandstone, shale, basalt, peridotite, and diabase with varying degrees of moisture was investigated experimentally. It was found that the maximum change in resistivity occurs at a certain average percentage of moisture but neither at maximum nor minimum. The greatest increase in electric conductivity was observed under comparatively low mechanical stresses (up to 200 kg. per cm.^{2}) and the greatest change in conductivity (50-100%) was observed in shale containing 28-32% of water. Such an increase in electrical conductivity of moist rocks is attributed to formation of continuous liquid current-conducting channels during compression of the rock. The results obtained should be taken into consideration in interpretation of deep electric-logging diagrams.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-214).

3-830. Parkhomenko, E.I. A STUDY OF THE TRIBOELECTRIC EFFECT IN ROCKS AND IN CERTAIN DIELECTRICS BY MEANS OF A DYNAMIC METHOD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 32-36, 6 illus., diag., 2 tables, 14 refs.

It is found that marble, plexiglas, polystyrene, amber, and ebonite, having been electrified by friction, display very strong electrical oscillations when elastic vibrations pass through them. Conclusions are made concerning the bulk polarization of the dielectric appearing during the frictional electrification process based on the presence of polarity in the effect and on observations of the inverse tribolectric effect in marble and plexiglas.--Auth.

3-831. Svetov, B.S. CERTAIN RESULTS OF MODEL INVESTIGATIONS ACCORDING TO THE INDUCTIVE METHOD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 71-78, 13 figs., table, 2 refs.

The results of a series of modeling experiments and of theoretical study of quasi-stationary electromagnetic fields with respect to their frequency and amplitude-phase characteristics associated with an anomalistic field, and their relation to the form, location, and position of the disturbing ore body, the kind of the field source, and other factors are reported. It was found that the frequency and phase characteristics of anomalistic fields caused by conducting bodies can be expressed in terms of their parameters, independently of the form of the cross section of the body. This allows interpretation of geophysical anomalies of bodies of arbitrary cross section, without assuming a particular form. Determinations of anomalistic parameters from the frequency characteristic of the anomaly and from measurements of amplitude and phase at a fixed frequency are found to be equally reliable. Multifrequency amplitude-phase measurements are to be used in detailed exploration of the anomalies and where the ore body is complex.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-182).

3-832. Vilkov, N.V. EXPERIENCE OF DETERMINATION OF POROSITY OF STRATA ACCORDING TO SP PARAMETERS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1051-1053, 2 diags., log, 2 tables, 1958, pub. 1960.

The paper briefly indicates a graphical method for calculating porosity of strata from the self potential (SP) log. Use is made of a linear relationship which exists between the coefficient A (or ratio of the average value of the self potential to its amplitude) and the porosity of a sediment. No corrections are needed for the resistivity of the drilling mud, temperature, thickness of the strata, oil saturation, or other factors. The coefficient of correlation between the coefficient A and the porosity for Devonian sandstones of various fields was found to be 0.86 and 0.89 A comparison with data of core-studies yielded an average quadratic error of 8%, and the method was found to be satisfactory with the exception of nonuniform or thin strata (less than 1 m.).--C. Voûte.

3-833. Buryakovsky, L.A. DETERMINATION OF PERMEABILITY BY RESISTIVITY LOGGING: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 50-55, 3 diags., 2 tables, 1959, pub. 1960, 6 refs.

The paper gives formula relating the residual water saturation of a rock to its specific surface and porosity, water saturation to permeability and the thickness of the waterfilm in the pores, and permeability to the coefficient of increase of resistance and thickness of the waterfilm. The relationship is given between the thickness of the waterfilm, residual water saturation, specific surface and porosity, and the method is indicated for determining permeability on the basis of measurements of specific resistivity.--C. Voûte.

3-834. Zagarmistr, A.M., and M.N. Berdichevsky. ELECTRIC PROSPECTING BY THE TELLURIC CURRENTS METHOD: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 40-49, 8 figs. incl. 2 maps, 1959, pub. 1960, 2 refs.

Discusses method and interpretation of prospection by measuring variations of the natural electrical field of the earth. The basic factors causing anomalies in the field of telluric currents are variations in the thickness and mean resistivity of the sedimentary rock lying on a nonconducting basement, called the marker electrical horizon. Changes in lithology of the sediments and in mineralization of subsurface waters must be taken into account in order to obtain reliable information. Examples of regional investigations are cited from the western and southern part of the Siberian lowland and from the border area of the Baltic depression in the Latvian S.S.R. Examples of detailed surveys are mentioned from the Shatilkov depression (B.S.S.R.), from the central part of the Pechora basin and from the northern part of the Bashkir A.S.S.R. The method, in combination with gravimetric and aeromagnetic surveying, is especially efficient during investigation of poorly studied areas which are difficult of access. However, under conditions of permafrost the telluric currents method has not yet had satisfactory results.--C. Voûte.

3-835. Keller, George V., and Frank C. Frischknecht. ELECTRICAL RESISTIVITY STUDIES ON THE ATHABASCA GLACIER, ALBERTA, CANADA: U.S. Natl. Bur. Standards, Jour. Research, v. 64D (Radio Propagation), no. 5, p. 439-448, 17 figs. incl. map, profiles, diags, graphs, Sept.-Oct. 1960, 10 refs.

The use of electrical methods for measuring ice thickness and properties on the Athabasca Glacier, Alberta, Canada, has been studied by the U.S. Geological Survey. Two methods for measuring resistivity were tried: 1) a conventional resistivity method in which current was introduced galvanically into the glacier through electrodes, and 2) the other an electromagnetic method in which a wire loop laid on the ice was used to induce current flow. Results of the galvanic measurements showed large variations in the resistivity of the ice; in a surface layer several tens of feet thick the resistivity is between 0.3 and 1.0 megohm-meters, and under this layer, the resistivity of the ice is more than 10 megohm-meters. The resistivity of the surface ice is determined by its water content rather than by molecular resonance loss. The ice had no effect on the mutual coupling measurements in the frequency range from 100 to 10,000 cycles per sec. As a consequence the electromagnetic data could be interpreted simply in terms of ice thickness and bedrock resistivity.--Auth.

3-836. Fremd, V.M. ON THE POSSIBILITY OF THE APPLICATION OF THE MULTISTAGE SCALE COMPRESSION DEVICE OF SEISMOGRAPHS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 211-213, diag., table, ref.

For multistage scale-compression system it is expedient to connect scale-compression shunts in series, in such a way that the scale-compression factor would increase in geometric progression. The 125-fold scale-compression system being applied at the seismic stations of the N. Tien-Shan zone is not excessively high.

For the satisfactory registration of earthquakes of various force it is necessary, besides the multistage scale-compression of the basic apparatus, to have at the seismic stations low-sensitivity instruments on which registration is performed during sufficiently strong earthquakes only. During motion of the ground with large amplitudes no noticeable parasitic oscillations of the galvanometer frame are caused which distort the recording.--Auth. concl.

3-837. Vogel, A.A. AUTOMATIC EQUIPMENT AT THE SEISMIC STATIONS OF THE NORTH-TIEN-SHAN ZONE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 154-158, illus., 2 diags., 4 refs.

The paper submits a description of the equipment installed at the seismic stations of the N. Tien-Shan zone intended for the automatic increase of the filament voltage, introduction of multistage scale compression device ("zagrublenie"), and a warning system during the recording of earthquakes.--Auth.

3-838. Rudolph, William E. CATASTROPHE IN CHILE: Geog. Rev., v. 50, no. 4, p. 578-581, Oct. 1960, refs.

The earthquakes of May 1960 in Chile affected 1,000 mi. of the country, killed 1,000 persons, and destroyed 65,000 dwellings. Changes in submarine topography require the revision of navigation charts for 800 mi. of waterway. Intensity of the destructive shocks ranged from 7.25 to 8.50 on the modified Mercalli scale. An accompanying seismic sea wave caused only moderate damage to Chile but killed 180 persons in Japan and Okinawa. Renewed volcanic activity followed the quakes.--M. Russell.

3-839. Murata, K.J. VIGIL FOR DISASTER: GeoTimes, v. 5, no. 5, p. 12-13, 2 illus., Jan.-Feb. 1961.

At 11 p.m., May 22, 1960, 6 men stationed themselves on the shore of Hilo Bay at the Wailuku River bridge, Oahu, Hawaii, to wait for the possible arrival of a strong tsunami from Chile. An eye-witness description is given of the arrival of a 3-ft. wave, then a 9-ft. wave, and ultimately a 20-ft. wall of water which forced the observers to flee to higher ground.--M. Russell.

3-840. Leonov, N.N. THE KHAIT EARTHQUAKE OF 1949 AND THE GEOLOGICAL CONDITIONS OF ITS ORIGINATION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 274-283, 4 illus., 5 maps, 12 refs.

An earthquake of magnitude 9 recorded on July 10, 1949, at 9^h54^m local time occurred in the Garm region near Khait in the Tadzhik S.S.R. Geomorphological consequences of the earthquake are discussed, and seismic and geological maps are presented. The Khait earthquake took place at the juncture of the Tien Shan and Pamir where the Djirgatal block and the northern part of Peter I range are undergoing intense uplift while the Kabut-Crimea block and the valley of the Surkhob river are under an equally intense subsidence. The relationship of this earthquake to the ruptures that separate the blocks is confirmed by: 1) the configuration of the epicentral zone and the characteristic distribution of the seismic waves; 2) the distribution of geomorphological dislocations on the surface of the earth; 3) the location of the main focus; and 4) the distribution of the aftershocks and the character of the dislocations.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-87).

3-841. Gzovsky, M.V., and others. NEW PRINCIPLES IN ESTABLISHING SEISMIC REGIONS, BASED ON AN EXAMPLE FROM CENTRAL TIEN-SHAN: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 121-133, no. 3, p. 235-245, 12 maps, 3 diags., graph, table, 42 refs.

An attempt is made to determine zones of various degrees of seismic danger on the basis of the seismicity and geologic structure of the Tien Shan. The linear correlation between the log of the number of earthquakes and that of their energy, discussed in pt. 1, led to the conclusion that the seismicity zones of the Tien Shan can be qualitatively determined from the mean values of the gradient of tectonic movements in the zones. Various geologic methods used in the determination of these mean values are described in detail in pt. 2. Strong earthquakes originate in the zone of junction of large structural elements of the earth's crust that have movements of different sense. It was also found that the energy of strong earthquakes is directly proportional to the size of these elements.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-96).

3-842. Savarensky, E.F., and Mei Shi-Yun. ON THE EVALUATION OF THE INTENSITY OF EARTHQUAKES IN THE TERRITORY OF CHINA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 86-88, 4 figs. incl. map, table, 11 refs.

A method is developed for determining approximate values of seismicity in China based on geophysical data and the earthquake chronicles of the country. Eleven earthquakes that have occurred in Chian since 1918 are analyzed, and their magnitudes (M) evaluated according to $M = (2/3)I_o + (4/5) \log h - (1/2)$, where I is intensity of the earthquake analyzed according to Medvedev's scale and h is depth of the focus determined from the mean values of isoseists according to the chronicles data.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-103).

3-843. Mei, Shi-Yun. THE SEISMIC ACTIVITY OF CHINA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 254-264, 12 figs. incl. 4 maps, graphs, 5 tables, 16 refs.

A continuation of studies of the seismic activity of China by Savarensky and Mei (see above). An improved formula is presented that correlates magnitude M, focal depth h, and intensity I_o of an earthquake: $I_o = (0.9 \pm 0.6) + (1.5 \pm 0.08)M - (1.3 \pm 0.36) \log h$, derived by the least square method from the data on 23 earthquakes (1918-1958) of magnitude 4.4 to 8.5. Seismicity maps from instrumental and historical data (for 3,000 years) are given. Seismicity characteristics of separate zones are discussed and compared. The variation of seismic activity with time is studied, and the possibility of a 1,000 yr. periodicity in the seismicity of China is suggested. Recurrence of earthquakes as a function of their magnitudes is discussed.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-104).

3-844. Glivenko, E.V. DETERMINATION OF A REFRACTING BOUNDARY FROM AZIMUTHAL STATION DATA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 313-316, 4 figs., 4 refs.

The method of correlation of refracted seismic waves proposed by Gamburtsev and Galperin is discussed, and positions of refracting boundaries are determined from the records of local earthquakes by an azimuthal station which consists of several seismographs. This problem was solved with the aid of geometric constructions based on the assumption of a plane refracting layer which is located at a depth that is small compared with the distance from the station to the focus of the earthquake, and which lies on a homogeneous medium. A mathematical treatment of the problem is given. Examples show that the bearings of the recorded seismic rays provide qualitative data on the refracting boundary parameters, and more reliable results are obtained even without the use of statistics.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-122).

3-845. Glivenko, E.V. CONVERTED AND REFLECTED WAVES ON AZIMUTHAL SEISMOGRAMS OF EARTHQUAKES IN THE GARM REGION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 79-82, 12 figs. incl. diags., graphs, 4 refs.

Tests of azimuth seismographs in the Turkmen S.S.R. in 1951 and in the Garm region in 1953 showed that the apparatus records ground displacement in various directions, and that the displacement vector coincides with the direction of the seismic rays coming to the station. This defines the direction of the P-wave motion in its first arrival. The azimuth method of seismic recording is extended to the subsequent arrivals in an attempt to distinguish other wave types on the seismograms. Several hundred seismograms of local earthquakes were analyzed statistically. SP type waves were distinguished in the time interval between the first arrival of P- and S-waves. It was found that SP waves propagate at first as S-waves, and then are transformed by exchange into P-waves at a refraction boundary. PP waves, which arrive after the first arrival of S-waves, were also distinguished. Their origin is attributed to the existence of a deep (32-40 km.) discontinuity and a reflection boundary at a depth of 20 km.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-133).

3-846. Kogan, S.D. TRAVEL TIMES OF LONGITUDINAL AND TRANSVERSE WAVES, CALCULATED FROM DATA ON NUCLEAR EXPLOSIONS MADE IN THE REGION OF THE MARSHALL ISLANDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 246-253, 2 figs., 5 tables, 15 refs.

For the surface focus in the region of the western part of the Pacific Ocean the true travel time of a P-wave is 2 sec. less, of a PP-wave 5 sec. less, and of a PcP-wave 3 sec. less than that of the Jeffreys-Bullen travel-time curve. In comparison with this same travel-time curve the travel time of transverse waves is 4-5 sec. greater. If corrections for longitudinal waves can be nearly completely explained by the absence of a granite layer in the Pacific Ocean region, then corrections for transverse waves are most likely connected with the fact that the values for the velocity of S-waves in the upper part of the mantle are less than those which are accepted at the present time.--Auth.

3-847. Ulomov, V.I. SOME SPECIAL FEATURES IN THE STRUCTURE OF THE EARTH'S CRUST IN CENTRAL ASIA ACCORDING TO RECORDS OF HIGH-POWER EXPLOSIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 83-85, secs., 12 refs.

Analysis of seismograms of 29 seismic stations in central Asia obtained from a powerful explosion 100 km. from Tashkent on Dec. 19, 1957, made it possible to construct a 1,000-km. profile of the crust. The profile was constructed according to the transverse traveltime curves of P^* and P head waves related respectively to the basalt and Mohorovičić discontinuities for a distance of more than 300 km. The high sensitivity of the seismographs VEGIK, SGK, and SVK, the high speed of the recording tape (120-240 mm. per min.), and the radio signal of the moment of the explosion made it possible to determine the depth of the discontinuities with an accuracy of ± 5km. A gravity-geological map covering an area of about 1,000 km. by 200 km. was compiled.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-478).

3-848. Holzmann, F.M. THE FREQUENCY THEORY OF INTERFERENCE SYSTEMS. I: Akad. Nauk. SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 3-11, 6 figs., 2 tables, 4 refs.

The paper examines problems of the synthesis of interference systems for the separation of waves having different apparent velocities in the directions of the coordinate axes. In the general case, the synthesis of interference systems is reduced to the selection of 3-dimensional frequency characteristics and to the calculation of their reciprocal Fourier integral. The frequency characteristics of the discrete systems are periodic. An examination is made of the basic concepts of the theory of filtration of velocities on the basis of which the frequency characteristics are selected. The article adduces examples of the synthesis of interference systems by the assumed values of the apparent velocities of effective and interference waves.--Auth.

3-849. Holzmann, F.M. THE FREQUENCY THEORY OF INTERFERENCE SYSTEMS. II: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 142-148, 8 figs., 3 refs.

Theoretical results obtained in pt. 1 [see above] are used to derive methods for the synthesis of systems in terms of given directional characteristics, and applications of these methods are considered.--Auth.

3-850. Myachkin, V.I., and R.N. Soloveva. STUDY OF THE PROPAGATION OF ELASTIC WAVES OF ULTRASONIC FREQUENCY OVER SMALL DISTANCES IN ROCKS, UNDER CONDITIONS OF NATURAL DEPOSITION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 37-44, 7 figs., 2 tables, 21 refs.

Utilization of ultrasonic impulse apparatus with

Rochelle salt transducers and use of the method of longitudinal profiling makes it possible to measure the velocities of propagation of elastic waves and to determine the elastic constants of rocks under conditions of natural deposition. For bases on the order of 0.3 - 1.0 m. the accuracy of determination of the velocity reaches 1-3%.

As a result of the experiments carried out in the shafts of the Kalush K mine, the values of the velocities of the direct longitudinal and Rayleigh waves in sylvanite were determined ($\underline{v}_\rho$ = 3,500-3,700, $\underline{v}_R$ = 1,800-1,900 m./sec. and in zuber ($\underline{v}_\rho$ = 4,100, $\underline{v}_R$ = 2,100 m./sec., on the basis of which the elastic constants for these rocks were calculated. The coefficients of quasianisotropy were determined. The data obtained could be used both for engineering work and for seismic prospecting.--Auth. concl.

3-851. Shamina, O.G. THE DEPENDENCE OF THE DAMPING OF IMPULSES IN LAYERS OF FINITE THICKNESS ON THE FREQUENCY SPECTRA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 98-100, 5 figs., 7 refs.

The results of special model experiments to determine the absorption coefficients of P-waves in a finite layer by the impulse ultrasonic method are reported. Frequency analysis of impulses of equal duration, propagating in layers of finite thickness and having the same predominant frequency but different form, showed that the wider the spectrum of the impulse in the region of lower frequencies, the lower the attenuation of its amplitudes.--A.J. Shneiderov (courtesy Geophysical Abstracts 181-170).

3-852. Zverev, S.M. DYNAMIC PECULIARITIES OF MULTIPLE REFLECTED "WATER" WAVES IN THE OCEAN AND THEIR USE IN THE DETERMINATION OF ELASTIC WAVES IN SEDIMENTS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 1, p. 12-20, 12 figs. incl. illus., graphs, 15 refs.

An analysis is conducted of the travel time and amplitude curves of multiple reflected water waves found on profiles of deep seismic sounding in the Sea of Okhotsk and the Pacific Ocean. It is shown that the shape of the amplitude graphs is determined by a change in the reflection coefficient in relation to the incidence angle at the ocean floor.

Possibilities are discussed for determining the velocity in sediments by the experimental amplitude graphs of multiple reflected water waves.--Auth.

3-853. Levshin, A.L. THE INTERPRETATION OF DATA ON THE DISPERSION OF SURFACE WAVES USING BILOGARITHMIC GRIDS OF THEORETICAL DISPERSION CURVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 208-210, 4 figs., 6 refs.

Parameters of a surface layer and an underlying medium can be determined from data on phase velocity dispersion of Love waves in the media, and those of the earth's crust from the dispersion of group velocities of Rayleigh waves. A method of interpretation of the observational dispersion data by comparing them with theoretically constructed bilogarithmic master charts is discussed. This method produces a more complete and accurate interpretation of seismic surface wave dispersion in a layered medium and is also simpler than other methods.--A.J. Shneiderov (courtesy Geophysical Abstracts 182-133).

3-854. Ivanova, T.G. ON THE APPLICATION OF SEISMIC FREQUENCY SOUNDING FOR THE INVESTIGATION OF THE UPPER PART OF A CROSS-SECTION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 149-153, 5 figs. 9 refs.

The paper adduces some new experimental data in regard to the variation in the apparent angles of incidence of waves onto the surface of the earth during the tuning of the apparatus for the registration of various frequencies. It has been established that the angles of incidence of the waves are affected by a soil layer of insignificant thickness.

An interpretation is presented of the dependence of the apparent angle of incidence of a wave on the frequency of the oscillations being recorded, and the velocity in the soil layer as well as its thickness have been determined.--Auth.

3-855. Halperin, E.I., and A.V. Frolova. AZIMUTH-PHASE CORRELATION OF ELLIPTICALLY POLARIZED SEISMIC WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 134-141, 9 figs., 8 refs.

The theory of the azimuth-phase correlation of elliptically polarized waves is examined. The features of azimuthal seismograms are investigated. Methods are proposed for the solution of the converse problem of finding the wave polarization parameters. --Auth.

3-856. Biot, Maurice Anthony. INSTABILITY OF A CONTINUOUSLY INHOMOGENEOUS VISCOELASTIC HALF-SPACE UNDER INITIAL STRESS: Franklin Inst., Jour., v. 270, no. 3, p. 190-201, diag., graph, Sept. 1960, 10 refs.

Surface folding due to instability is analyzed for continuously inhomogeneous half-space of viscoelastic properties. The medium is under the combined action of a horizontal compression and gravity. The material is of uniform density. Its viscoelastic properties vary exponentially with depth so that it degenerates into a fluid at large depth. It is assumed that the deformations verify the thermodynamic theory of irreversible processes. Folding wavelengths are evaluated. The general correspondence principle as formulated earlier by the author shows the results to be immediately applicable to either viscoelastic or purely elastic media. A numerical application to the geophysical scale indicates that a continuous viscosity gradient resulting from the temperature variation with depth cannot account for orogenesis by the mechanism of instability in compression.--Auth.

3-857. Zavyalov, V.D. MASS AREAL SEISMIC SURVEYING IN THE CARPATHIANS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1044-1050, map, 3 secs., 1958, pub. 1960, 6 refs.

In view of the very complex subsurface of the oil-bearing inner zone of the Cis-Carpathian downwarp, with its thrust fault in the southwestern part, several methods of geophysical prospection have been tried, but with little success. Therefore a different method of seismic work was tried, called mass areal seismic surveying (MPS). It is a reflection method consisting of massive-scale areal determination of elemental reflecting surfaces, instead of continuous profiling. The areal position of a reflecting surface is determined by observations on 2 or 3 short intersecting profiles of not more than 300-500 m. each. Even under complex conditions reflected waves can generally be detected. Errors in interpretation are decreased by securing a statistical average of the results. Sufficiently reliable exploration results are obtained where the angle of dip of the reflecting surface is not less than 10-15°. The paper gives a brief account of the deep tectonics of the region surveyed below the massive overthrust. It shows a strong development of transverse faults cutting the folded structures in narrow blocks displaced in different degrees one to another. Periclinal parts of anticlines and the over-all size of the blocks can be determined more or less from the location of local gravity minima. Similar structures are found in the Skibov zone of the Carpathian mountains.--C. Voûte.

3-858. SEISMIC CRUSTAL STUDIES DURING THE IGY. PART I: MARINE PROGRAM: Am. Geophys. Union, Trans., v. 41, no. 1, p. 107-113, 3 maps, March 1960; also pub. as: Natl. Acad. Sci., IGY Bull., no. 33.

Scripps Institution of Oceanography, Lamont Geological Observatory, and Woods Hole Oceanographic Institution in the United States collaborated in the marine IGY Seismology Program. One-fourth of the seismic measurements included the entire crustal thickness above the Moho discontinuity. The total marine area covered by participating groups was almost global; however, Scripps concentrated its activities in the South Pacific between French Oceania and South America, while Lamont and Woods Hole studied the Caribbean Sea between Central America and Greater Antilles, the continental border from Buenos Aires to Cape Horn, the Scotia Sea between Falkland and Sandwich islands, the Cape of Good Hope area, and the Gulf of Aden, Red Sea, and Mediterranean Sea. Some unusual South Pacific findings: under Nasca Ridge (SW. of Peru) the crust appears to be 15 km. thick, one of the greatest oceanic crustal thicknesses; at 4 locations under the Easter Island rise no velocity greater than 7.5 km./sec. was measured, despite long profiles. In the South Atlantic, the continental border off Argentina has a layer of bottom sediments having velocities of 1.6-2.4 km./sec., averaging 2 km. in thickness, but thickening to 5 km. on the continental slope, beyond which it is again 2 km. S. of the Falkland Islands a 100-fathom-deep bank, extending 100 km. N.-S. and 330 km. E.-W., has a sediment layer (4.5 km./sec.) thickening from 1 km. on the N. to 8 km. beneath the bank and absent to the S., raising a question as to the bank's origin. In the Indian Ocean, at the shallow mouth of the Gulf of Aden, 2 sedimentary layers having velocities of 1.85 and 3.9-4.6 km./sec. with a combined thickness of 2 to 4 km., were recognized beneatn which the crustal material has a velocity of 6.4-6.8 km./sec., whereas gravity surveys had indicated the base of the crust should be at 17 km. below sea level. Gravity and magnetic highs identified with a submarine trench extending most of the length of the Red Sea can be related to high-velocity (7.1 km./sec.) crustal material probably resulting from basic rock intruding a fracture system in the graben.--A.C. Mason.

3-859. Voskoboinikov, G.M. ON THE THEORY FOR INTERPRETING GAMMA-RAY LOGS IN LAYERED MEDIA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 176-179, fig., 5 refs.

A method for calculating the gamma field in a radiating-absorbing layered medium by means of an equivalent transformation into a medium of uniform density is considered. This transformation leads to a general theorem for the area bounded by the gamma-anomaly curve. The theorem can be used to compute the linear reserve of the radiation source in a medium of variable density.--Auth.

3-860. Bulashevich, Yu. P., and S.A. Shulyatev. OPTIMUM CONDITIONS FOR CONTINUOUS ACTIVATION LOGGING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 170-175, 4 figs., 15 refs.

The distribution of the density of activated atoms along the shaft of a bore was obtained with activation by a moving constant or impulse source of neutrons, and the dependence of this distribution on the rate of logging and the parameters of the medium was examined.

An expression was also obtained for the number of activated atoms and the intensity of the γ-radiation in logging with respect to points. Numerical values for activation effects for bauxite deposits are cited. --Auth.

3-861. Ivanova, V.F., and V.K. Khristianov. NEUTRON LOGGING IN PROSPECTING FOR INDUSTRIAL CONCENTRATIONS OF BORON: Geokhimiya [in translation], 1956, no. 2, p. 192-197, 3 figs., pub. 1960, 4 refs.

Experimental study and field testing proves the applicability of neutron logging to the search for ores of B in sedimentary and endogenetic environments. Results from 13 boreholes in a known deposit of B ore shows that neutron logs adequately outline the ore bodies. Without sharp fluctuations in H content and in the absence of elements with anomalous cross-section of neutron capture, the differentiation grows with the size of the probe.--M. Russell.

3-862. Levin, B. Yu., and S.V. Maeva. THERMAL HISTORY OF THE EARTH: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 2, p. 163-169, 6 figs., table, 21 refs.

Computations are presented on the thermal history of an originally cold earth for a series of models of the earth which differed by the mean amount of its radioactive elements, the heat capacity of its interior and the influence of radiant thermal conductivity. The development of the earth's crust is considered a lengthy process which began 3×10^9 years ago. Radiant thermal conductivity exerts a considerable influence on the computed heat flow which agrees with the observed heat flow containing fewer radioactive elements than was previously assumed. Comparison of theoretical values of heat flows for the earth's areas between the continental and oceanic crusts showed that the difference in heat flow is less than the differences in the thickness of the crust. This is caused by the fact that the heat radiates not only from the crust, but also from deeper layers. This conclusion agrees with the fact that observations do not establish noticeable systematic differences in the heat flows between the continents and oceans.--Auth.

3-863. Lustig, E.N. CONVECTION IN THE EARTH'S MANTLE: Akad. Nauk SSSR, Izvestiya,

Geophysics Ser., in translation, 1960, no. 1, p. 1-2, diag., 10 refs.

Less than 6% of the total output of the sources of heat responsible for convection can be transmitted to the earth's crust, that is not more than 10^{26} erg/yr. This does not contradict an estimation of the output of tectonic processes according to seismic data.--Auth.

3-864. Arbolishvili, D.Z. THE GEOTHERMAL REGIME OF SOME AREAS IN THE GEORGIAN SSR: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1034-1038, map, table, 1958, pub. 1960, 3 refs.

The results are presented of geothermal measurements made in 7 boreholes in the Rioni-Kura basin from the shore of the Black Sea to E. of Tbilisi with the aid of Hg maximum thermometers and electro thermometers. Some drill holes have lain idle for a long period; measurements in others were carried out a few days only after the well was shut down. The geothermal gradient varies between 1.43°C./100 m. and 3.40°/100 m. The stratigraphic sections tested varied between Lower Cretaceous and Miocene. It was found that the temperature depends not only on the depth in which the rocks occur but also on their stratigraphic position. In drill holes located in identical geotectonic environments, similar magnitudes of temperature correspond to one and the same group of strata.--C. Voûte.

3-865. Sorokhtin, O.G., and others. METHODS AND PRINCIPAL RESULTS OF SEISMIC AND GRAVIMETRIC STUDIES OF THE STRUCTURE OF THE EASTERN ANTARCTICA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 3, p. 265-268, sec., 7 refs.

A brief description is presented of the methods of seismically and gravimetrically determining the thickness of ice under Antarctic conditions. Expediency of a general utilization of these methods is shown. Finally, a cross section is described of the glacial cover along the profile Mirnyy-Pole of Inaccessibility. Some conclusions are drawn as to the geological structure of the E. Antarctic mass.--Auth.

7. GEOCHEMISTRY

See also: Areal and Regional Geology 3-764; Mineralogy 3-898, 3-902, 3-905; Sedimentary Petrology 3-915; Mineral Deposits 3-934 through 3-937, 3-939, 3-944, 3-951; Fuels 3-971, 3-972.

3-866. Pillay, T.C.M., and others. STABILITY OF HERCYNITE AT HIGH TEMPERATURES: Am. Ceramic Soc., Jour., v. 43, no. 11, p. 583-585, 2 graphs, 2 tables, Nov. 1960, refs.

The free energy of formation of the spinel $FeAl_2O_4$ from its constituent oxides has been determined in the temperature range 1,550° to 1,700°C. The method used involved determination of the gas ratio p_{H_2O}/p_{H_2} in equilibrium with liquid Fe, corundum, and hercynite and previously published data on the same gas equilibrium with liquid Fe and FeO. The values of ΔF^o at 1,550° and 1,700°C. are respectively -3690 and -3490 cal. per mole.--Auth.

3-867. Heyding, R.D., and G.J.G. Despault. THE COPPER/ARSENIC SYSTEM AND THE COPPER ARSENIDE MINERALS: Can. Jour. Chemistry, v. 38, no. 12, p. 2477-2481, table, Dec. 1960, 12 refs.

In addition to the α solid solution of As in Cu, 3 intermediate phases exist in the Cu/As system. The ϵ phase, stable only below ca. 340°C., has the hexagonal A3 (D^4_{6h}, $P6_3/mmc$) structure with $a = 2.588$, $c = 4.226$ Å, and the approximate formula Cu_8As. The compound $Cu_{3-x}As$, with $0 < x < 0.3$, is trigonal (D^4_{3d}, $P\bar{3}c1$) with $a = 7.132$, $c = 7.304$ Å at $x = 0$. This compound has no polymorphic forms between 200°C. and the melting point. The As-rich compound $Cu_{5-u}As_2$, with $0 < u < 0.1$, melts incongruently at about 700°C., and decomposes at 300°C. to As and Cu_3As. The structure has not been determined, but the powder diffraction pattern is recorded. The solubility of Cu in As appears to be negligible.

It is suggested that the mineral α domeykite is a high-pressure phase, and that the mineral algodonite is a high-pressure modification of the ϵ phase. The mineral β domeykite is isostructural with Cu_3As.--Auth.

3-868. McKinstry, Hugh E. THE SYSTEM Cu-Fe-S-O: Econ. Geology, v. 55, no. 6, p. 1314, Sept.-Oct. 1960, 2 refs.

A note of errors in a paper by the author (GeoScience Abstracts 1-2538). The mineral pairs chalcocite-tenorite and covellite-tenorite were joined by tie-lines in the phase diagram of the ternary system Cu-S-O. Actually both joins would be precluded by a join between chalcocite and copper sulfate which was erroneously omitted from the diagram. This means that, in a later diagram, the joins covellite-hematite and chalcocite-cuprite-hematite are also eliminated. The only stable 3-phase assemblage in the ternary system is native Cu-chalcocite-cuprite.--J. A. Chamberlain.

3-869. Markham, N.L. SYNTHETIC AND NATURAL PHASES IN THE SYSTEM Au-Ag-Te: Econ. Geology, v. 55, no. 6, p. 1148-1178, Sept.-Oct. 1960; no. 7, p. 1460-1477, Nov. 1960, 10 illus., 9 diags., table, 48 refs.

The subsolidus phase relationships in the ternary system Au-Ag-Te have been investigated experimentally. From the results obtained an isothermal section at 300°C. has been drawn showing compatible phases and approximate limits of solid solution. All natural gold-silver telluride minerals, with the exception of krennerite and montbrayite, have been synthesized. It is concluded that krennerite is the low-temperature, low-pressure polymorph of $AuTe_2$ and the higher temperatures and pressures favor the development of calaverite.

A detailed mineralogical description is given of the telluride deposits of Kalgoorlie, Western Australia, and Vatukoula, Fijian Islands. The assemblages observed are compared with those obtained experimentally, and there is found to be good agreement between the 2 sets of data. The natural assemblages have also been analysed in terms of the phase rule. It is concluded that experimental data are still insufficient to indicate a meaningful range of temperatures over which any given telluride deposit could have formed but that the calaverite-krennerite transition, when experimentally determined, should provide a most useful geological thermometer.--Auth.

3-870. Khitarov, N.I. THE 400° ISOTHERM FOR THE SYSTEM H_2O-SiO_2 AT PRESSURES UP TO 2,000 KG/CM^2: Geokhimiya [in translation], 1956, no. 1, p. 55-61, illus., diag., 2 graphs, 3 tables, pub. 1960, 3 refs.

The investigation has been carried out in a special high-pressure apparatus by studying quartz stability in water. Figures show decline of quartz stability with increasing pressure and that the temperature effect upon quartz stability is more strongly expressed than the pressure effect. Experimental data for 2 points of the adjoining 450° and 350° isotherms at P = 3,000 kg./cm.^{2} and the quartz stability at 400° and 2,000 kg./cm.^{2} in solutions of NaOH, $NaHCO_3$, and NaCl with a concentration of 0.5 normal are given.--Auth.

3-871. MacChesney, J.B., and Arnulf Muan. THE SYSTEM IRON OXIDE-TiO_2-SiO_2 IN AIR: Am. Ceramic Soc., Jour., v. 43, no. 11, p. 586-591, 7 diags., Nov. 1960, refs.

Phase relations at liquidus temperatures in the system iron oxide-TiO_2-SiO_2 have been determined in air. The equilibrium existence of the crystalline phases magnetite(ss), hematite(ss), pseudobrookite(ss), rutile(ss), and silica (tridymite or cristobalite) has been established. Three isobaric eutectic points are formed by the intersections of quaternary liquidus univariant lines of the system Fe-Ti-Si-O and the 0.21 atmosphere isobaric surface. The liquid miscibility gaps present in the bounding "binary" systems iron oxide-SiO_2 and TiO_2-SiO_2 extend across the composition triangle representing the "ternary" system iron oxide-TiO_2-SiO_2. Liquidus temperatures decrease within the 2-liquid region from approximately 1,670°C. in the system iron oxide-SiO_2 and 1,780°C. in the system TiO_2-SiO_2 to 1,540°C. at the cristobalite-rutile(ss) boundary curve which bisects the 2-liquid region. Paths of equilibrium crystallization of representative mixtures are discussed with reference to a simplified projection into the plane $FeO \cdot Fe_2O_3$-TiO_2-SiO_2 as well as in terms of the tetrahedron representing the system FeO-Fe_2O_3-TiO_2-SiO_2.--Auth.

3-872. Yang, Julie Chi-Sun. THE SYSTEM MAGNESIA-SILICA-WATER BELOW 300°C.: I, LOW-TEMPERATURE PHASES FROM 100° to 300°C. AND THEIR PROPERTIES: Am. Ceramic Soc., Jour., v. 43, no. 10, p. 542-549, 6 figs. incl. illus., graphs, 3 tables, Oct. 1960, refs.

Reactions in the ternary system MgO-SiO_2-H_2O were studied over the temperature range 100° to 300°C. and were found to produce only 2 phases. Under conditions of 100° to 200°C. and atmospheric pressure up to 20,000 lb. per sq. in., and regardless of the initial MgO/SiO_2 ratio, the predominant magnesium silicate product was found to have a MgO/SiO_2 ratio of 1.5. In the range 200° to 300°C. at 210 to 20,000 lb. per sq. in., 2 stable phases, $3MgO \cdot 2SiO_2 \cdot 2H_2O$ (I) and $3MgO \cdot 4SiO_2 \cdot H_2O$ (II), were observed. In this case the phase that was favored was determined by the molar ratio of MgO/SiO_2 of the reaction mixture at the start of the run. The physical and chemical properties of phases (I) and (II) resembled those of the natural minerals serpentine and talc respectively. Two different morphologies were observed in electron micrographs of phase (I). From 100° to 160°C. it occurred as crumpled foils; at 170°C., fibrous crystallites, which resembled the natural asbestos mineral chrysotile, appeared at the expense of some of the foils.--Auth.

3-873. Naughton, John J., and Yasuo Fujikawa. MEASUREMENT OF INTERGRANULAR DIFFUSION IN A SILICATE SYSTEM: IRON IN FORSTERITE: Hawaii, Univ., Inst. Geophysics, Contr. no. 15, [4] p., 2 figs., 1959, 7 refs.; reprinted from: Nature, London, v. 184, p. B.A. 54-B.A. 56, Sept.5, 1959.

Geochemists and petrologists concerned with the role of solid state diffusion in material transfer in silicate systems have noted the possibility that grain boundaries and dislocations might act as avenues for relatively rapid movement of the diffusing ions. Some preliminary measurements on a silicate system where grain boundary diffusion seems to predominate in diffusive transfer are given. The system used was polycrystalline forsterite (magnesium orthosilicate) with ferrous ion as the diffusing material.

Within the limitations of the conditions and the system studied, the results tend to support those who discount the role of diffusion in long-distance mass transfer, even through the supposedly easy route of the grain boundary.--L.M. Dane.

3-874. Kapustinsky, A.F. GEOSPHERES AND CHEMICAL PROPERTIES OF ATOMS: Geokhimiya [in translation], 1956, no. 1, p. 44-54, 2 figs., pub. 1960, 13 refs.

Consideration of the data on atomic structure, quantum mechanics, crystal thermodynamics, and seismology leads us to the following conclusions: the 2 extreme points of view on the structure of the earth, that is, the theory of a layered structure according to Goldschmidt, and Lodotshnikov's idea of a homogeneous structure of the globe, are both wrong. The "solid" globe consists of 3 geospheres, the centrisphere, the intersphere, and the perisphere. The centrisphere (2,900 km.) is isothermal (2,000°C.) and consists of a completely metallized zone of null chemism. The intersphere is characterized by degenerated chemical properties of atoms due to the transition of electrons "smashed in" by high pressure to internal energy levels, the formation of which has not yet been accomplished. Only the relatively thin perisphere (60-120 km. from the surface) is completely in accordance with the usual chemical ideas and may be called the zone of normal chemism where chiefly proceed transformations of matter leading to the formation of the rocks, ores, and minerals that we know and which appear at the surface.--Auth.

3-875. Krinov, E.L. PRINCIPLES OF METEORITICS. Translated from the Russian by Irene Vidziunas: 535 p., illus., maps, diags., graphs, 52 tables, New York, Pergamon Press, 1960, 270 refs.

In recent years the study of meteorites has taken on a more and more systematic character and has been carried on in different scientific foundations. The science dealing with meteorites - meteoritics - has been enriched by new factual data. Concurrently with this there has been proof of the great significance of meteoritics in relation to cosmogony and of the importance of an all-round study of meteorites in connection with the problem of the origin of the planetary system. This has reinforced the demand for the fullest possible survey literature on meteorites. The aim of this book is to give a reasonably full grasp of the principles underlying meteoritics and to indicate the most important of the problems with which the science is confronted.--From auth. pref.

Topics discussed are: meteoritics as a branch of science; motion and fall of meteorites; morphology, chemistry, mineralogy and petrography, and physical properties of meteorites; tektites and silica-glass; and origin of meteorites. Appendices: catalogue of meteorites of U.S.S.R. on Jan. 1, 1959; meteorites of rare type; classification of surface structure of fusion crust of meteorites. An index of meteorites is included.

3-876. Yavnel, A.A. REGULARITIES IN THE COMPOSITION OF METEORITE SUBSTANCE AND A CLASSIFICATION OF IRON METEORITES: Geokhimiya [in translation], 1956, no. 2, p. 203-219, 9 figs., pub. 1960, 13 refs.

A consideration of general principles of meteorite classification by the composition of their substance brings forth the necessity of selection of the chemical composition as a primary classifying characteristic. In that respect, Prior's classification is outstanding among the others, although it is in need of further improvement. The presence of definite regularities in the chemical composition of meteorites makes possible a division of meteorites of all 3 classes into 6 subclasses and 5 groups, thus possibly supplying a foundation for a meteorite classification. A consideration of the mineralogical, petrographic, and metallographic properties determines a classification scheme of meteorites by their chemico-mineral composition and structure. On the basis of certain regularities in the chemical composition and structure of meteorites, certain assumptions may be made about their origin.--Auth. summ.

3-877. Starik, I.E., and M.M. Shats. DETERMINATION OF URANIUM IN STONY AND IRON METEORITES: Geokhimiya [in translation], 1956, no. 2, p. 140-148, 5 tables, pub. 1960, 20 refs.

The data on U content in 3 stony meteorites (Saratov, Elenovka, Kunashak) were obtained by 2 independent methods: fluorescence and activation. Average U content in stony meteorites is $2.4 \cdot 10^{-7}$ g./g. Data reveal fair consistency in U distribution in stony meteorites and are in perfect accordance with Paneth's data and a step higher than those of Patterson and Davis. U content was determined separately for chondrules and cement of stony meteorites. U determination for both the gray and the black varieties of the Kunashak meteorite shows a fairly uniform U distribution throughout the meteorite.

U content in 4 Fe meteorites (Sikhote-Alin, Chinge, Chebankol, Avgustinovka) was determined by the 2 above-named methods. Average U content in the Sikhote-Alin, Chebankol, and Chinge Fe meteorites is $1.9 \cdot 10^{-8}$ g./g. Its content in the Avgustinovka meteorite was found to be $0.8 \cdot 10^{-8}$ g./g, which is probably connected with the structural peculiarities of this meteorite. Our data on the distribution of U in Fe meteorites do not confirm those by Turkevich and Reed, who give a considerably lower U content in Fe meteorites.--Auth. summ.

3-878. Petrzhak, K.A., and others. ISOTOPIC COMPOSITION OF URANIUM IN METEORITES: Geokhimiya [in translation], 1956, no. 2, p. 149-158, 3 diags., pub. 1960, 23 refs.

The isotopic composition of U of meteoritic and terrestrial occurrence is the same within 1%. This indicates the following: a) terrestrial and meteoritic U have had the same origin; b) the law of radioactive decay holds equally for the terrestrial and meteoritic U; c) neutron fields, capable of altering the isotopic composition of meteoritic U, were absent in places where meteorites occur.--Auth. concl.

3-879. Vinogradov, A.P. REGULARITY OF DISTRIBUTION OF CHEMICAL ELEMENTS IN THE EARTH'S CRUST: Geokhimiya [in translation], 1956, no. 1, p. 1-43, 4 tables, pub. 1960, approx. 175 refs.

The total chemical composition of the principal rock types has been subjected to a critical examination, namely the chemical composition of: 1) ultrabasic rocks (dunites, peridotites, pyroxenites); 2) basic rocks (gabbros, basalts, diabases, norites etc.); 3) intermediate rocks (andesites and diorites); 4) acid rocks (granites, rhyolites, ziparites etc.) as well as of the sedimentary rocks (clays and shales) and of the silicate phase of chondrites. For the principal constituents of the massive rocks, namely Si, Al, Fe, Ti, Mg, Ca, K, Na, P, Mn (and O) the weighted mean has been calculated according to Daly's, Nockold's, and the author's data (for the rocks of U.S.S.R.); for the clays and shales according to the data of Clarke, Hougen et al.; and according to the author's data for the clays of all ages of the Russian platform, etc. For all the other rarer and more scattered chemical elements average data (arithmetical) have been calculated on the basis of extensive known material (systematized in tables).

The principal regularities in the distribution of chemical elements in rocks, being chiefly determined by the law of isomorphism, and the correlation of the chemical rock composition with the mineralogical composition have been considered.

The identity of the silicate phase composition of chondrites and dunites is pointed out in detail. In comparing the clay + shale composition with granites, attention is attracted by the high content of Cr, Ni, Co, V, Cu and a number of other chemical elements in the sediments compared to granites. That is of particular interest in connection with the idea of the granitization process. The average composition of the earth's crust practically for all elements equals the composition of the mixture - 2 parts of granites + 1 part of basalts. A resulting table of the above mentioned rocks is given.--Auth.

3-880. Vainshtein, E.E., and others. REGULARITIES IN THE DISTRIBUTION OF RARE EARTHS IN CERTAIN MINERALS: Geokhimiya [in translation], 1956, no. 2, p. 159-178, 9 figs. incl. map, 7 tables, pub. 1960, 17 refs.

A study of the distribution of rare earths in various rare-earth minerals points out a regularity in the change on content of this mineral group in minerals of different origin.

In some provinces, monazites and allanites of pegmatitic origin are found to be relatively poor in the lightest rare-earth elements. Conversely, the same minerals of a hydrothermal origin exhibit a rise in the relative content of Ce and La and a corresponding decrease in Sm content. At the same time, the distribution of rare earths in rock-forming monazites and allanites of granitoids exhibit a high degree of consistency.

A study of granitoids of the Ukrainian massif has shown the ratio of the individual rare earths and their over-all content in these rocks (about 0.04%) to be practically constant, and not affected by the age of the intrusions nor by the percent content and type of their accessory minerals. For this region, the rare-earth content of rocks differs from that of accessory minerals in the higher content of heavier elements of this group.

This leads to the belief that although the bulk of rare earths is contained in monazite and allanite, some portion of these elements is tied up in other minerals (sphene, zircon, garnets, etc). The content and distribution of rare-earth elements in the studied schist, which lacks accessory minerals, coincides with those in granitoids of the Ukrainian shield.--Auth. summ.

3-881. Tauson, L.V., and L.A. Kravchenko. CHARACTERISTICS OF LEAD AND ZINC DISTRIBUTION IN MINERALS OF CALEDONIAN GRANITOIDS OF THE SUSAMYR BATHOLITH IN CENTRAL TIAN-SHAN: Geokhimiya [in translation], 1956, no. 1, p. 78-88, 4 tables, pub. 1960, 5 refs.

The study of Pb distribution in minerals of granitoids of the Susamyr batholith has shown that nearly 80% of this element is bound to feldspars, being found completely in the form of an isomorphous mixture only in the K-feldspars. Nearly 40% of the Pb is contained in the rock in an "extrasilicate" form, which is readily leached out of the rock. Mineralogically such a form may be represented by submicroscopic particles of galena or native Pb. The limited possibility of Pb isomorphism in granitoid minerals as well as the fact that it is partially found in the rocks in an "extrasilicate" form have been substantiated.

Nearly 70% of the Zn content in these granitoids is concentrated in iron-magnesium silicates. The Zn concentration in these minerals exceeds by nearly tenfold the concentration of the element in the rock. However, almost all the Zn does not occur in these minerals as an isomorphous admixture, and more than 80% of it is extracted out of the rock by specific solvents. It is thought that the principal mass of Zn atoms is present in the rock in a mobile "extrasilicate" form. It has been shown that such a Zn distribution agrees with the crystallochemical properties of this element.--Auth.

3-882. Beus, A.A. CHARACTERISTICS OF THE ISOMORPHOUS ENTRY OF BERYLLIUM INTO CRYSTALLINE MINERAL STRUCTURES: Geokhimiya [in translation], 1956, no. 1, p. 62-77, 8 tables, pub. 1960, 23 refs.

The peculiarities of isomorphous entry of Be into the crystalline structure of minerals, being determined by the structure and properties of its ion, have been examined. The possibility of a limited isomorphism of Be with Si has been proved on condition that there is a parallel compensation of electrostatic equilibrium: a) in the cation part by a parallel entry into the structure of some cations of high valency (rare earths, Zr, Ti etc.-feldspars, garnet, steenstrupine, clinohumite etc.) in place of mono and bivalent cations; b) in the anion part - by substituting $(SiO)^4$ by (BeO_2) $(F,OH)_2)^{4-}$ (margarite, muscovite, phlogopite, vesuvianite, allanite, etc.). Known and possible examples of isostructural isomorphism of Be compounds with silicates include willemite, calcamine, cordierite, forsterite, cyrtolite, thorite, etc., and borosilicates such as homilite and datolite. Taking bavenite as an example the possibility of a Be-Al isomorphism is demonstrated.--Auth.

3-883. Khitarov, N.I., and E.V. Rengarten. GEOCHEMISTRY OF CARBONIC ACID IN GRANITIC INTRUSIONS: Geokhimiya [in translation], 1956, no. 2, p. 198-202, diag., 3 tables, pub. 1960, 2 refs.

Carbonic acid plays a substantial role in the process of magmatic differentiation. Data on gaseous and liquid inclusions in minerals are especially interesting. They aid in a quantitative evaluation of the part played by carbonic acid in the formation of the rock itself and in interpretation of the geological and physicochemical environment wherein carbonic acid is produced.

The carbonic-acid content of granites from 3 areas of the U.S.S.R. was studied: Primore (maritime region), Kazakstan, and the Caucasus. A regularity in the distribution of CO_2 in the mineral components feldspar, quartz, and biotite was found. The highest amounts occur in biotite, possibly due to the high partial pressure of CO_2 during crystallization of biotite resulting in gas inclusions qualitatively rich in the gas. Alternatively it may be that the crystal lattice of biotite favors the entry of CO_2 into its lattice.--M. Russell.

3-884. Cooper, L.H.N. A SYSTEM FOR INTERNATIONAL EXCHANGE OF SAMPLES FOR TRACE ELEMENT ANALYSIS OF OCEAN WATER: Jour. Marine Research, v. 17, p. 128-132, 1958, pub. 1960, ref.

The hazards inherent in sampling at sea for trace element analyses are discussed. It is proposed that a discussion be held at Helsinki in 1960 on: a) sampling for trace element analysis; b) a system for international exchange of samples and for reciprocal control of methods for analysis of trace elements.--Auth.

3-885. Armstrong, Francis A.J. INORGANIC SUSPENDED MATTER IN SEA WATER: Jour. Marine Research, v. 17, p. 23-34, fig., 2 tables, 1958, pub. 1960, 22 refs.

The suspended matter in sea water has been separated with membrane filters (down to 0.1 μ A.P.D.); the inorganic fraction, determined by ignition, has been partly analysed. The methods used are briefly described. An appreciable quantity of finely divided claylike material was found, and it is suggested that, by adsorption of organic matter from the water, this may support the bacterial flora. Samples taken regularly from the English Channel show a seasonal variation, the quantity found being greatest in winter and ranging from 0.16 to 1.20 mg/l, the mean being 0.6 mg/1. The analyses showed approximately 43% SiO_2, 13% Fe_2O_3, and 13% Al_2O_3. Si in suspension generally exceeded that in solution.

At 3 deep-water stations in the eastern Atlantic, rather smaller quantities of suspended matter (0.05-1.00 mg/1) compared to the Channel were found. Some of the figures may be high owing to precipitation of calcium carbonate during storage. In the upper waters Si in suspension exceeded that in solution, but below c. 100 m. the reverse was the case. The amount of Fe in suspension resembled that found by direct analysis. Some results for Al in suspension show quantities around 37 μg Al/1. in the English Channel and around 12 μg in the eastern Atlantic.--Auth.

3-886. Pate, John B., and Rex J. Robinson. **THE (ETHYLENEDINITRILO)TETRAACETATE TITRATION OF CALCIUM AND MAGNESIUM IN OCEAN WATERS. I. DETERMINATION OF CALCIUM: Jour. Marine Research, v. 17, p. 390-402, 5 tables, 1958, pub. 1960, 31 refs.**

Various factors influencing the determination of Ca in ocean water by (ethylenedinitrilo) tetraacetate titration have been investigated. Using Cal-Red as indicator, the method has been applied in titrating 36 ocean samples. A Ca-chlorinity ratio of 0.02134 was obtained. The speed, preciseness, accuracy and simplicity of the method should encourage its future use.--Auth.

3-887. Goldberg, Edward D. **DETERMINATION OF OPAL IN MARINE SEDIMENTS: Jour. Marine Research, v. 17, p. 178-182, 2 graphs, 2 tables, 1958, pub. 1960, 2 refs.**

The opal contents of recent sediments are ascertained by conversion of the opal to crystobalite by heating and by a subsequent quantitative X-ray diffraction analysis of the crystobalite. An opal stratigraphy is evident in Bering Sea deposits. Further, the opal concentrations appear to be covariant with Ba, an element previously suggested as indicative of biological productivity in overlying water masses.--Auth.

3-888. Koczy, F.F., and Heinz Titze. **RADIUM CONTENT OF CARBONATE SHELLS: Jour. Marine Research, v. 17, p. 302-311, fig., 2 tables, 1958, pub. 1960, 15 refs.**

Ra determinations have been made for shells from Swedish waters, the Mediterranean Sea, and the Pacific Ocean. Their Ra/Ca ratio has been estimated and compared to the Ra/Ca ratio in sea water. It was found that, in general, the Ra/Ca ratio is proportional to the Sr/Ca ratio found by Thompson and Chow.

Removal of Ra from surface waters changes the Ra content of the water. It is estimated that the rate of this precipitation is of the same order of magnitude as the rate of decay of Ra in the water. Since Ra is also taken up by phytoplankton, it is concluded that the apparent half-life of Ra in surface waters is only one-third of the natural decay constant.--Auth.

3-889. Ostroumov, E.A. **DISTRIBUTION OF TITANIUM IN SEDIMENTS OF THE OKHOTSK SEA: Geokhimiya [in translation], p. 89-96, 2 charts, pub. 1960, 21 refs.**

Most of Ti enters the Okhotsk Sea with terrigenous material arising from the decay of various rocks as well as with pyroclastic material (ash). Part of the Ti connected with coarse fragmental material is concentrated in sandstones and sandstone-aleurite deposits of the areas in the arc of the Kurile islands, the western coast of the Kamchatka peninsula and the northern coast of the sea. The rest of the Ti, in the form of colloidal Ti minerals, is confined to pelites and is concentrated in muds.--Auth.

3-890. Riley, J.P., and Prapas Sinhaseni. **CHEMICAL COMPOSITION OF THREE MANGANESE NODULES FROM THE PACIFIC OCEAN: Jour. Marine Research, v. 17, p. 466-482, 6 tables, 1958, pub. 1960, 52 refs.**

Three Mn nodules from the Pacific Ocean have been analysed for 35 elements by using mainly spectrophotometric and spectrographic methods. Cu, Co, Ni, Zn, and Pb were found in amounts approaching 1%, which far exceeds their average concentrations in igneous rocks. On the other hand, elements having readily hydrolysable ions, such as Ga, Sc, Zr, Y, La, and Ti, are present only in amounts comparable with their concentrations in igneous rocks. Sb, Bi, Be, and Cr were not detected. The hydrochloric acid-insoluble fraction of nodules is practically free of the heavy metals that are characteristic of the acid-soluble fraction; it consists principally of clay minerals, together with lesser amounts of quartz, apatite, biotite and Na and K feldspars.--Auth.

3-891. Germanov, A.I. **A POSSIBLE HYDROCHEMICAL CAUSE FOR DEVELOPMENT OF A SUBZONE OF LEACHING: Geokhimiya [in translation], 1956, no. 1, p. 117-122, diag., pub. 1960, 5 refs.**

The leaching subzone, developed in a number of pyrite deposits, forms under certain conditions in the zone of seasonal variations of the ground-water level. This zone is characterized by seasonal alternations of intensive oxidation and reduction conditions ($Fe^{3+} \rightarrow Fe^{2+}$ etc.). For this reason in deposits rich in pyrite and other sulfides but with a poor carbonate content, where acid waters are formed, above the ground water level in this zone Fe (Fe^{3+} and Fe^{2+}) and many other elements are more rapidly removed. As a result at favorable conditions in this zone in a number of pyrite deposits there are formed silica-barite sands or analogous deposits, very poor in Fe, Cu, and a number of other components. This also gives rise to the formation, in the oxidation zone, of an interval very poor in the occurrences of some elements, the valency of which changes during supergene processes.--Auth.

3-892. Sato, Motoaki. **OXIDATION OF SULFIDE ORE BODIES, II. OXIDATION MECHANISMS OF SULFIDE MINERALS AT 25°C: Econ. Geology, v. 55, no. 6, p. 1202-1231, diags., graphs, 3 tables, Sept.-Oct. 1960, 63 refs.**

Measurements of the single electrode potentials of sulfide minerals backed with basic understanding of their electrode behavior make it possible to clarify their oxidation or reduction mechanisms. The electrode potential of a sulfide mineral is controlled by the first-step reaction of the oxidation mechanism for the sulfide in an oxidizing solution, and by that of the reduction mechanism in a reducing solution. Sulfides of Cu, Pb, Ag, Fe, and Zn were studied. The results indicate that the direct oxidation of a simple sulfide mineral is a process in which the metal atoms move into the surrounding solution to become aqueous cations, accompanied by a step-wise decrease in the metal to S ratio of the remaining solid phase. When solid S is finally left over, it undergoes a series of reactions to be oxidized to sulfate ion. In case of reduction, S atoms move out into the solution to become aqueous sulfide ions with a step-wise increase in the metal to S ratio of the solid phase. To illustrate, the oxidation of chalcocite proceeds as

$$(Cu_2S) \rightarrow 1/5(Cu_9S_5 + Cu^{++})? \rightarrow (CuS + Cu^{++}) \rightarrow 2(Cu^{++} + S).$$

The path of the step-wise oxidation is not necessarily the same as that of the step-wise reduction for a metal-S system. In the case of disulfides of Fe, namely pyrite and marcasite, ferrous ions and S_2 molecules appear to be released simultaneously upon oxidation.--Auth.

Pt. 1 of this paper has not yet been published.

3-893. Warren, Harry V. HEALTH AND GEOLOGY: Western Miner, v. 33, no. 8, p. 35-42, pl., 3 tables, Aug. 1960, 24 refs.

The knowledge possessed by geologists, particularly geochemists, should be integrated with that of other investigators working in the fields of medicine, agronomy, and forestry. Health is not just an absence of disease, but represents an appropriate integration of the elements of the atmosphere, hydrosphere and lithosphere. The constituents of the hydrosphere and atmosphere, dominantly forming organic matter, are much more evenly dispersed than are those of the lithosphere, which make up a much smaller proportion of living material. In areas where anomalously high quantities of metals occur in the lithosphere, it may be fruitful to discover what happens when specific elements make their way into food products, and are consumed in turn by higher organisms.--Auth. and J. A. Chamberlain.

3-894. Finney, John W. SCIENTISTS REFINE 'ATOM CALENDAR': New York Times, v. 110, no. 37,608, p. 15, cols. 3-5, Jan. 11, 1960.

The half life of C^{14} is 5,760 years on the basis of a redetermination by the U.S. Bureau of Standards. The new figure, nearly 200 years longer than the old, results in placing the age of the Dead Sea scrolls at about 20 B.C. rather than 40 A.D.--M. Russell.

3-895. Vinogradov, A.P. THE ISOTOPIC COMPOSITION OF SULFUR IN CONNECTION WITH THE GROWTH OF PYRITES OF SEDIMENTARY ORIGIN: Geokhimiya [in translation], 1956, no. 1, p. 97-108, 4 figs., 5 tables, pub. 1960, 6 refs.

The isotopic composition of the S of pyrite and sulfate of sedimentary origin of different ages of formation has been investigated. The mass-spectral measurements of the samples have been carried out on an apparatus which allowed recording of the variations of S^{32}/S^{34} with an accuracy up to $\pm 0.01\%$, compared with the isotopic composition of sulfates from sea water. As a standard in all these measurements a troilite from the Sikhota-Aline meteorite has been used, accepting for it S^{32}/S^{34} equalling 22.20. It has been proved that S^{34} is abundant in sulfates and essentially low in sulfides.

The maximum spread of the ratio of S isotopes between the "lightest" pyrite and the "heaviest" sulfate reaches 8%. The obtained data for 47 pyrite (and sulfate) samples were graphically compared with the time of their formation and, contrary to the Canadian investigators (Todt el al.), it has been shown that the isotopic S composition does not show any age correlation.--Auth.

3-896. Chow, Tsaihwa J. LEAD ISOTOPES IN SEA WATER AND MARINE SEDIMENTS: Jour. Marine Research, v. 17, p. 120-127, 5 tables, 1958, pub. 1960, 11 refs.

The Pb concentration obtained from sea water samples of San Juan Channel, Washington, was 0.2 μg/l. or less. Leads isolated from Pacific and Atlantic pelagic clay sediments show an isotopic composition similar to that of Mn nodules from the respective oceans. The Pb^{206} content in the Atlantic Pb was more abundant than that in the Pacific Pb. This finding agrees with the postulate that the Atlantic Pb was derived from rocks which contained high proportions of old granites and that the Pacific Pb was from rocks containing high proportions of relatively young basalts.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Areal and Regional Geology 3-766; Geochemistry 3-867, 3-887; Igneous Petrology 3-909; Mineral Deposits 3-932, 3-958, 3-959.

3-897. Zeller, Edward J., and W.C. Pearn. DETERMINATION OF PAST ANTARCTIC CLIMATE BY THERMOLUMINESCENCE OF ROCKS: Am. Geophys. Union, Trans., v. 40, no. 1, p. 118-121, 2 figs., March 1960; also pub. as: Natl. Acad. Sci., IGY Bull., no. 33.

Light is emitted from a thermoluminescent mineral by energy release when electrons move from "trapped" to normal positions within the mineral's crystal lattice. The traps result from negative ion vacancies or from impurity ions. Ionization induced by radiation emitted by radioactive impurities cause electrons to be displaced into these traps, where at low temperatures they are held. Upon heating the electrons are released and return to their normal position, causing light to be emitted. Thermoluminescent properties are represented graphically by glow curves showing variation of light intensity with temperature, and decay curves showing decay rate from glow peaks with the sample at a steady temperature. Comparing graphs for natural samples with those for portions irradiated artificially permit inferences about the thermal history. In 1958 samples of about 50 carbonate rocks were collected chiefly in the McMurdo Sound region of Antarctica. The 125°C. low peak found in many samples, being sensitive to small changes and permitting simplification of procedures, was used instead of the pronounced glow-curve peaks at 235°C. and 310°C. To determine the decay rate, samples were held at 25°C. The results indicate at least 170,000 years have elapsed since temperatures fell low enough to permit accumulation of electrons in the 125°C. traps.--A.C. Mason.

3-898. Butler, J.R., and Rosemary Hall. CHEMICAL CHARACTERISTICS OF DAVIDITE: Econ. Geology, v. 55, no. 7, p. 1541-1550, 2 graphs, table, Nov. 1960, 25 refs.

Twelve davidites from several localities and of different parageneses have been analysed for U and individual rare earths. The abundance of the total lanthanons invariably exceeds that of Yt, and the distribution of the individual lanthanons is strikingly similar for all specimens: both the heavy and light lanthanons are more abundant than the middle lanthanons. La generally exceeds Ce and may exceed the sum of the remaining lanthanons.--Auth.

3-899. Fayaz, Hashem. **MESGARABAD MINE, IRAN:** Rocks & Minerals, v. 35, no. 7/8, p. 333-335, 4 illus., July-Aug. 1960.

A remarkable cavity in massive gypsum was encountered during exploitation of the Mesgarabad Mine, 10 km. E. of Tehran. Inner walls were lined with prismatic crystals of gypsum up to 40 cm. in length. Properties and some constants of the gypsum are furnished.--J. Sinkankas.

3-900. Shipp, R. F., and R. P. Matelski. **A MICROSCOPIC DETERMINATION OF APATITE AND A STUDY OF PHOSPHOROUS IN SOME NEBRASKA SOIL PROFILES:** Soil Sci. Soc. America, Proc., v. 24, no. 6, p. 450-452, 2 figs., table, Nov.-Dec. 1960, 18 refs.

A microscopic method for the determination of apatite frequencies consists of adding heavy mineral fractions of soils to 2 or 3 drops of 10.7 normal H_2SO_4 on a glass slide. Needle-like calcium sulfate crystals develop on the apatite grains, making them easily recognized. Similar crystals form on fluorite, calcite, dolomite, aragonite, and siderite. The fluorite is distinguished by its anisotropic character, and the calcite and dolomite effervesce in the H_2SO_4. Aragonite and siderite are distinguished by their strong birefringence and lack of pleochroism. The following Ca and Mg minerals did not produce needle-like crystals: andesine, anorthite, augite, biotite, bytownite, chlorite, diopside, enstatite, epidote, glauconite, grossularite, gypsum, hornblende, hypersthene, labradorite, oligoclase, olivine, phlogopite, serpentine, spinel, talc, titanite, tourmaline, tremolite, vesuvianite, and zoisite.

A study in Nebraska of Tripp and Sharpsburg soil profiles show a downward increase in apatite and P content. The Valentine soil had a uniformly low apatite content.--R. Van Horn.

3-901. Mitchell, Richard S., and E. H. McGavock. **APATITE FROM THE MOREFIELD PEGMATITE, AMELIA COUNTY, VIRGINIA:** Rocks & Minerals, v. 35, no. 11/12, p. 553-555, illus., 2 tables, Nov.-Dec. 1960, 16 refs.

Although known for 80 years as a constituent of the pegmatites near Amelia, Virginia, apatite from these localities has not been studied to any extent. Specimens of apatite were collected from masses of cleavelandite at night using ultraviolet lamps. The apatite fluoresces bright orange-yellow and it is a simple matter to collect numerous specimens in a short period of time. Apatite in grains and crystals from less than 1 mm. to over 5 mm. in diameter occurs associated with quartz and cleavelandite. The apatite is light gray, white, or pale greenish in color. Crystals are short stubby prisms rich in faces, of which twelve forms are identified. X-ray powder data comparing favorably with typical fluorapatite patterns are furnished. Approximate unit cell values are: a=9.53 A, c=6.86 A; a:c=1:0.734. Data are also furnished on fluorescence and phosphorescence, the latter evident only upon excitation by X-rays. Strong orange-yellow thermoluminescence is a characteristic property. Semiquantitative spectrographic analysis indicates 2 to 3% Mn, and this element is postulated as the fluorescence activator. --J. Sinkankas.

3-902. Shcherbina, V. V., and L. I. Ignatova. **FORMATION AND SOLUTION OF AUTUNITE: Geokhimiya [in translation], 1956, no. 2, p. 179-183, 2 graphs, pub. 1960, 7 refs.**

The discussed data describe the geochemical environments which favor or prevent formation of autunite, one of the most widely distributed U minerals in supergene zones. Autunite and cuprosklodowskite are mutually exclusive minerals. Ca and Pb are so distributed between uranosilicates and uranophosphates that there form uranophosphate of Pb or uranosilicate of Ca (uranophane).--M. Russell.

3-903. Jorgensen, Neil. **A BERYL OCCURRENCE AT MOODY MOUNTAIN, OXFORD COUNTY, MAINE:** Rocks & Minerals, v. 35, no. 11/12, p. 547-549, illus., map, Nov.-Dec. 1960.

Small green and blue beryl crystals occur in several pegmatite bodies on the SW. slope of Moody Mountain in northern Oxford County, Maine. Moody Mountain is in the township of Andover North Surplus, 6 mi. NW. of Andover village. The area is embraced by the Old Speck quadrangle of the U.S.G.S. topographic map series. Pegmatite dikes and sills are emplaced in granodiorite. Pegmatite bodies are divided into 2 types according to mineralogy. The first type is distinguished by salmon to pink perthite plus quartz, muscovite, and biotite and the absence of beryl, the second type by the presence of white to cream perthite plus quartz, muscovite, and beryl. Zoning appears to be absent, but 1 pegmatite contains masses of quartz up to 12 in. in diameter which may be regarded as a core unit. Beryl crystals are neither large nor abundant, nor has any gem quality material been found, although it has been previously reported. Crystals of beryl have not been found exceeding about 2 1/2 in. in diameter. -- J. Sinkankas.

3-904. Seaman, David M., and Robert P. Gallant. **SPESSARTITE GARNET WITH HEXOCTAHEDRAL FACES FROM JAIL HILL, HADDAM, CONNECTICUT:** Rocks & Minerals, v. 35, no. 9/10, p. 445-448, 5 figs., Sept.-Oct. 1960.

Microscopic spessartite garnet crystals displaying hexoctahedral faces are found in small vugs and in seams in a garnet mass enveloped in mica schist. Basic crystal form is the trapezohedron modified by the hexoctahedron and dodecahedron, but all forms are not always present on the same individual. Directions and a map to the locality are furnished. The geology of the deposit is briefly described and field aspects of the deposit shown on a sketch map. Crystals from this locality are compared to spessartites from other localities. Brief remarks are made upon the mineralogy of the deposit and its probable mode of formation.--J. Sinkankas.

3-905. Foster, Margaret D. **INTERPRETATION OF THE COMPOSITION OF LITHIUM MICAS:** U. S. Geol. Survey, Prof. Paper 354-E, p. 115-147, 15 figs. incl. diags., graphs, 8 tables, 1960, 40 refs.

A study of more than 100 analyses of Li micas reported in the literature indicates that, compositionally, most of the Li micas may be interpreted as if derived by isomorphous replacement from muscovite or siderophyllite.

Starting with muscovite, analyses and formulas of aluminum lithium micas, arranged in order of increasing Li content, are characterized by decrease in octahedral Al and in tetrahedral Al and by increase in Si and in octahedral occupancy. These changes can be interpreted as the result of progressive replacement of octahedral Al by Li, in ratios varying between 2 and 3 Li for octahedral Al. The aluminum lithium micas are not, however, members of a continuous isomorphous series. The series is interrupted about halfway between an octahedral occupancy of 2.00 and 3.00 by a change in structure from muscovite to lepidolite. The term "lithian" muscovite is given to aluminum lithium micas having a muscovite structure.

Starting with siderophyllite, or other trioctahedral micas having high Fe^{+2} and very low Mg content, analyses and formulas of ferrous lithium micas, arranged in order of increasing Li content, are characterized by decrease in Fe^{+2}, decrease in tetrahedral Al, increase in Si, and increase in octahedral occupancy. These changes can be interpreted as the result of progressive replacement by Li^{+1} of Fe^{+2}, at an average replacement ratio of 2.0 Li^{+1} for 1.5 Fe^{+2}. As there is less difference between the number of positive charges carried by the replacing cations and the replaced cations than in the aluminum lithium micas, the change in composition and the increase in octahedral occupancy is less in the ferrous lithium micas. The prototype, siderophyllite, is structurally trioctahedral, and, as replacement tends to increase octahedral occupancy, the ferrous lithium micas are also trioctahedral and no structural adjustments are necessary. The ferrous lithium mica series is, therefore, not broken as is the aluminum lithium mica series. Varietal definitions based on octahedral sites occupied by Li^{+1} in the half-cell formula are: lithian siderophyllite, having fewer than 0.25 sites occupied by Li^{+1}, protolithionite, having between 0.25 and 0.75 sites occupied by Li^{+1}, zinnwaldite, having between 0.75 and 1.25 sites occupied by Li^{+1}, and lepidolite, having more than 1.25 sites occupied by Li^{+1}.

The high-Li members of both series are lepidolites. Thus lepidolites may be interpreted as if derived from muscovite or from siderophyllite.--Auth.

3-906. Patchick, Paul F. A RARE EARTH PEGMATITE NEAR NUEVO, CALIFORNIA: Rocks & Minerals, v. 35, no. 7/8, p. 323-327, 2 maps, July-Aug. 1960, 3 refs.

One of several granitic pegmatites in tonalite near Nuevo, California, has been exploited as a source of silica from a large quartz core. A total of 16 minerals, of which 6 are rare-earth minerals, have been identified. Various species occurring in the pegmatite are briefly described. Of special interest are xenotime, monazite, cyrtolite, yttrialite, samarskite, yttrocrasite, and columbite. A discredited species, nuevite, later found to be samarskite, came from this quarry. Detailed instructions for reaching the locality are given, along with a map for guidance. Another map (after Jahns), illustrates the geology of the pegmatite. Tips for collectors and a list of minerals found at the locality are also included.--J. Sinkankas.

3-907. Norris, Robert M., and Charles D. Woodhouse. MINERALS FROM THE BEACH AT SANTA BARBARA: Gems & Minerals, no. 279, p. 21, 54, 55, 2 photomicrographs, Dec. 1960.

The beaches near Santa Barbara, California, are derived entirely from the sandstones of the nearby Santa Ynez Range. For all practical purposes, these sands consist solely of quartz and feldspar, however, approximately 1% consists of various heavy minerals, and these make the sands worthwhile studying under low-power magnification. Heavy minerals in the sands are defined as those exceeding sp. gr. 2.88. Magnetite, and probably picotite and other spinels make up about 60% of the concentrated heavy minerals. The next most abundant species at about 17% of heavy concentrates is garnet, probably andradite, but also containing some almandite. The latter is estimated to compose about one third of the garnet total. Zircon crystals and grains compose about 15% of the heavy minerals; strong UV fluorescence is a feature of this mineral. The brilliant golden-yellow glow is probably due to small amounts of rare-earth elements. The remaining species observed are epidote, brown tourmaline and sphene, and, more rarely, hornblende, apatite and topaz.--J. Sinkankas.

3-908. Rowley, Elmer B. MONAZITE AND CYRTOLITE CRYSTALS AT DAY, NEW YORK, PEGMATITE: Rocks & Minerals, v. 35, no. 7/8, p. 328, 330, illus., July-Aug. 1960, 5 refs.

The mineralogy of the Overlook pegmatite in the town of Day, Saratoga County, has been previously described by various writers, but no mention has been made of allanite, monazite, and cyrtolite crystals from the pegmatite. Monazite and cyrtolite occur intimately associated and intergrown with polycrase. Several choice specimens showing monazite crystals intergrown with polycrase are described and one is illustrated. In order of decreasing abundance the radioactive minerals are: polycrase, monazite, cyrtolite.--J. Sinkankas.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Geochemistry 3-883.

3-909. Baranov, V.I., and G. Tleuberghenova. APPLICATION OF THE MICRO-RADIOGRAPHIC METHOD UTILIZING LIQUID EMULSIONS TO A STUDY OF THE CONTENT AND DISTRIBUTION OF RADIOACTIVE ELEMENTS IN ROCKS: Geokhimiya [in translation], 1956, no. 2, p. 184-191, 3 figs., pub. 1960, 2 refs.

A method of applying a liquid photographic emulsion directly to the surface of a rock section being investigated for radiographic determinations is described. This method detects the sources of α-particles recorded on the emulsion and makes it possible to determine the shape and size of radioactive inclusions and their position and to establish the cause of radioactivity of each grain. It demonstrates whether the radioactive elements are in a state of high dispersion or are contained in accessory minerals. Application of the method insures a perfect contact between the photosensitive layer and the rock surface.--M. Russell.

3-910. MacDonald, Gordon A. **THE ACTIVITY OF HAWAIIAN VOLCANOES DURING THE YEARS 1951-1956: Hawaii, Univ., Inst. Geophysics, Contr. no. 14, 70 p., 20 illus., 13 maps, sec., 3 graphs, 1959, 29 refs.; reprinted from: Internatl. Union Geodesy & Geophysics, Assoc. Volcanologie, Bull. Volcanologique, ser. 2, v. 22.**

During the decade 1940-1950 Hawaiian volcanic activity was restricted wholly to Mauna Loa. Early in the next decade, however, activity shifted to Kilauea, leaving Mauna Loa quiescent. Eruptions in Kilauea caldera in 1952 and 1954 were followed in 1955 by a flank eruption 32 km. E. of the caldera. Thus the pattern at Kilauea during the first 5 years of the decade resembled the succession of summit eruption followed by flank eruption commonly observed on Mauna Loa.

The return of activity to Kilauea did not bring a resumption of the quasi-permanent lava lake activity long considered characteristic of that volcano. The continuous lava lake during the years previous to 1924 indicated a magma-filled conduit open to the surface, within which the accumulation of any large "head" of gas was impossible, and which consequently could not give rise to such large gas-rich fountains as have characterized the eruptions of Mauna Loa and the recent eruptions of Kilauea.

There appear to be no good grounds for assuming that the type of activity that characterized Kilauea during its first century of observation has been characteristic of the entire history of the volcano. The geologic structure of the volcano suggests that its activity has more generally resembled that of Mauna Loa, with frequent flank eruptions interspersed with short periods of summit activity. Thus the change in character of activity since 1924 may be a return to normal in the long-term history of the volcano.--From introd.

Sections are included on local seismicity, brief history of activity of Kilauea, earthquakes during 1951 and early 1952, the 1952 eruption of Kilauea, earthquakes and ground tilting during 1953 and early 1954, the 1954 eruption of Kilauea, earthquakes and ground tilting during the second half of 1954 and early 1955, the 1955 eruption of Kilauea, conditions at Kilauea and Mauna Loa, June 1955-Dec. 1956, and probable submarine eruptions in 1955 and 1956.

3-911. Timergazin, K. P. **THE DIABASIC ROCKS OF WEST BASHKIR: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1027-1034, map, profile, 1958, pub. 1960, 8 refs.**

Diabasic rocks, a description of which is given, have been found in deep boreholes in the W. and N. parts of the platform area of Bashkiria. They have a strictly local distribution and generally occur as steeply dipping dikes with a NE. strike in zones of faulting. They closely resemble the diabasic rocks of the W. Urals. Intrusion into the Archean gneissic basement and into sediments of the lower Bavlin suite is thought to have taken place in a single period, the absolute age of which is 1,010 million years to 1,140 million years as determined by the K-Ar method. The enclosing pre-Devonian terrestrial red beds and carbonate rocks of the lower Bavlin suite thus are dated as late Proterozoic and the terrestrial sediments of the upper Bavlin suite, which contain clastic fragments of these rocks as early Paleozoic.--C. Voûte.

10. SEDIMENTARY PETROLOGY

See also: Areal and Regional Geology 3-763; Geomorphology 3-781; Mineral Deposits 3-960, 3-962; Fuels 3-976.

3-912. Bates, Thomas F. **ROCK WEATHERING AND CLAY FORMATION IN HAWAII: Mineral Industries, v. 29, no. 3, p. 1, 4-6, 9 illus., May 1960, 7 refs.**

Because of extreme variation in rainfall, slope, and rock texture, Hawaii is an excellent place to study the tropical weathering of basic igneous rocks to clay minerals, to numerous oxides and hydroxides of Al, Fe, Ti, and Mn, and to X-ray-amorphous mineral and gel material. Extensive field study supplemented by preliminary differential thermal analysis, X-ray, light and electron microscope work reveals that the alteration process involves desilication and removal of alkali and alkaline earth elements. Resilication occurs only in local situations favoring temporary accumulation of Si.

Olivine weathers to serpentine, nontronite, goethite, and hematite; plagioclase to halloysite; and volcanic glass to palagonite and Al-Fe-Si gel or mineraloid material. Gibbsite forms by desilication of halloysite, dehydration of Al gel, and precipitation from Al-rich solutions. The formation of clay minerals is a common step in the structural transformation of primary silicates to end-product oxides, but the amount and relative importance of the clay "stage" depends on the intensity of the weathering process. Montmorillonitic clay is abundant only in dry areas. Halloysite is a common end-product in dry areas and an abundant intermediate-product in wet regions. The apparent absence of kaolinite in Hawaii is attributed to the paucity of muscovite and sericite which are considered by the author to be the common initial or intermediate phases in the formation of kaolinite by weathering. Allophane and Fe-Al gel are common in areas of high rainfall, particularly where volcanic ash is abundant.--Auth.

3-913. Krauss, Robert W., and Raymond A. Galloway. **THE ROLE OF ALGAE IN THE FORMATION OF BEACH ROCK IN CERTAIN ISLANDS OF THE CARIBBEAN: Louisiana State Univ., Coastal Studies Inst., Contr. no. 60-1; Caribbean Beach Studies, Tech. Rept. no. 11, pt. E, 49 p., 12 illus., 4 maps, 2 profiles, diag., 9 tables, March 1960, 20 refs.**

Notes on more than 80 beaches on Grenada, St. Lucia, Guadeloupe, and Puerto Rico are accompanied by comments on algae and other organisms with particular emphasis on the role they play in forming and modifying beach rock. It is concluded that algae are not directly responsible for cementation of beach rock. Incipient beach rock occurs in close association with the water table in the sand of beaches.

Spectrographic and quantitative analyses are given for water, sand, beach rock, and a sample of algal rock, from 7 beaches. Chloride and pH values are listed and Ca content of inshore and offshore waters tabulated for 17 beaches. Fifteen figures and a 20-item bibliography are included.

The conclusions advanced have general application in explaining beach rock origin generally. A detailed transect and tables showing relative abundance of various algae covering beach rock are of interest from the standpoint of reef origin.--Auth.

3-914. Greenberg, Seymour S. PETROGRAPHY OF INDIANA SANDSTONES COLLECTED FOR HIGH-SILICA EVALUATION: Indiana, Geol. Survey, Bull. 17, 64 p., 8 figs., pl., 9 tables, 1960.

Sandstones from the following stratigraphic units were collected for this study: St. Peter sandstone (middle Ordovician); Sample, Big Clifty, and Tar Springs formations (upper Mississippian); Mansfield formation (lower Pennsylvanian); Staunton, Linton, Petersburg, and Dugger formations (middle Pennsylvanian); and Shelburn formation and Merom sandstone (upper Pennsylvanian). The largest number of samples came from the Big Clifty and Mansfield formations, and the smallest number came from the St. Peter sandstone and Sample formation.

The upper Mississippian sandstones that were sampled are very fine to fine grained; the sandstone sampled from the Mansfield is fine to coarse grained; and the post-Mansfield sandstones that were sampled are very fine to medium grained. Size parameters obtained from cumulative frequency curves often can aid in the differentiation of sandstones.

The percentage (by weight) of heavy minerals generally is less than 0.5. Stable species, such as leucoxene, zircon, tourmaline, and rutile, as well as iron oxides (including magnetite), are the chief constituents of the heavy-mineral fractions. The light-mineral fractions contain abundant quartz and minor amounts of feldspar and muscovite and also sporadic traces of biotite and calcite. Kaolinite is more abundant than illite in all the sandstones sampled.

The immediate sources of all the sandstones generally were reworked sediments; nonsedimentary rocks (predominantly acid igneous) contributed very little detritus in the latest cycle of deposition. The middle and upper Pennsylvanian sandstones received more detritus from these nonsedimentary sources than did any other sandstones. The constituents of the Mansfield sandstones were reworked more than those of post-Mansfield age. Diagenesis, chiefly iron oxide staining and the formation of clay minerals, greatly affected the petrography of the sandstones.

This study indicates that mineralogic and chemical differences may be used to distinguish some sandstones but that these differences are not as usable for this purpose as size criteria.

Of all the sandstones studied, those from the Mansfield formation would be the best source of high-silica sand. Economic factors, such as overburden, extent of deposits, and cost of beneficiation, however, would influence greatly the commercial possibilities of the sandstones.--Auth.

3-915. Vinogradov, A.P., and A.B. Ronov. EVOLUTION OF THE CHEMICAL COMPOSITION OF CLAYS OF THE RUSSIAN PLATFORM: Geokhimiya [in translation], 1956, no. 2, p. 123-139, map, 9 graphs, 3 tables, pub. 1960, 28 refs.

A study was made of 252 composite samples of clay measures from 6,804 samples from the Russian platform to determine the chemical evolution of clays ranging in age from Riphean [late Proterozoic] through Quaternary. The main clay minerals in the Riphean, lower Paleozoic, and Devonian clays are hydromicas (illites) which are K rich and admixed with kaolinite in the continental (acidic) facies. Kaolinite acquires some importance in Carboniferous clays. Hydromica and kaolinite become predominant in Permian and Triassic clays. Clays display a tendency to increase the ratio Ca/Mg from older sediments to younger. Al and Ti effect regular and time-directed changes in clay composition. The maximum value of Th/U falls in the Riphean, Cambrian, and Jurassic. The chemical composition of clays has undergone, along with periodic fluctuations, some irreversible changes during the post-Proterozoic geologic history. The evolution has been determined by the course of the general evolution of the biosphere conditions. The outstanding influence of the material content of ancient land, and the proccesses active on it, on the chemical composition of sediments formed in the contemporaneous basins has been demonstrated.--M. Russell.

3-916. Smith, Robert L. ZONES AND ZONAL VARIATIONS IN WELDED ASH FLOWS: U.S. Geol. Survey, Prof. Paper 354-F, p. 149-159, 2 pls. (1 in pocket), 1960, 12 refs.

Welded tuffs are recognized as special parts of ash flows, other pyroclastic flows, or, more rarely, air-fall deposits. Ash flows may be emplaced at any temperature below a maximum eruption temperature. Those emplaced above a minimum welding temperature may show any and all degrees of welding and crystallization.

Three basic zones are recognized, the zones of no welding, partial welding, and dense welding. In sheets where the zone of dense welding occurs, the zones of no welding and partial welding will have upper and lower counterparts.

Cooling of welded ash flows may result in sheets that range from completely glassy (except for phenocrysts and inclusions) to mostly crystalline.

Crystallization superimposed on the zonal patterns produced by welding results in another set of zones that is controlled in part by degree of welding.

Three principal types of crystallization that take place during the cooling history are recognized. These in order of frequency of occurrence, are devitrification, vapor-phase crystallization, and granophyric crystallization. The zone of devitrification is common to most crystallized welded tuffs and frequently occupies most of the zones of dense welding and partial welding. The zone of vapor-phase crystallization, where present, occupies the porous parts of the welded tuff sheets and reaches its maximum development in the upper zone of partial welding where it overlaps the zone of devitrification. The zone of granophyric crystallization is probably confined to cooling units several hundreds of feet thick where it will divide the devitrified zone into upper and lower parts. Fumarolic alteration may be found in the upper zone of no welding.

Single ash flows may cool with the formation of a basic pattern of zones. This pattern is illustrated and described both for those sheets which remain glassy and for those in which crystallization has occurred. These flows are called simple cooling units.

Successive ash flows, emplaced quickly enough to bridge the cooling gap between flows, will form a stack of flows that may also cool to form the zonal pattern of a simple cooling unit. The gaps or hiatuses, here called partings, may contain or consist of lump pumice layers, flow surfaces reworked by wind or water, airfall pyroclastic material, other deposits, or minor erosional unconformities.

Compound cooling units consist of multiple flow units with or without visible partings and which show zonal patterns that depart from the patterns of the simple cooling units. Horizontal separation of compound cooling units into separate cooling units suggests the existence of a hypothetical unit, the composite sheet, which could have time-stratigraphic significance.

Buried topography can have a profound influence on the zonation of certain ash-flow cooling units. Very hot ones, because of their high compactability potential, will show less zonal change than colder ones, although they will show greater surface expression of the buried topography. Abrupt changes in relief, especially if the buried topographic high rises to the top of the zone of dense welding, can cause horizontal changes, in a short distance, that may be difficult to interpret.--Auth.

3-917. Bader, Richard G., and Vernon J. Henry. **MARINE SEDIMENTS OF PRINCE OF WALES STRAIT AND AMUNDSEN GULF, WEST CANADIAN ARCTIC: Jour. Marine Research, v. 17, p. 35-52, 2 maps, graphs, 2 tables, 1958, pub. 1960, 17 refs.**

Fifty-two marine sediment samples from Prince of Wales Strait and Amundsen Gulf have been analyzed for properties such as grain size and rock and mineral composition. It appears that the distribution of the various sediment types in the area investigated is markedly influenced by both stream location and sea ice.--Auth.

11. GEOHYDROLOGY

See also: Geologic Maps 3-722 through 3-732; Engineering Geology 3-1005, 3-1008.

3-918. Miller, Lynn M. **LOCATION AND EVALUATION OF GROUND WATER RESOURCES; Water & Sewage Works, v. 107 (Reference number), p. R107-R118, 8 illus., table, Oct. 1960, 3 refs.**

Evaluation of geology and surface work prior to new exploration is the best basis for the selection of exploration areas in a region. Electric resistivity and test drilling work should be coordinated to determine the best water-producing locations within an area. Aquifer performance test work can best be evaluated by using the geological, electric resistivity, and test drilling data as a guide to the interpretation of hydraulic responses observed. If large pumping rates are maintained over moderate test periods, it is possible to analyze test data without assigning absolute values for the coefficients of transmissibility and storage and estimate the interference of wells for the design of a well field.--Auth. summ.

3-919. Gunderson, N.E. **REVERSE CIRCULATION DRILLING: Water & Sewage Works, v. 107, no. 12, p. 470-474, 2 illus., 6 diags., Dec. 1960.**

In the past 2 decades, increased use of reverse circulation drilling has resulted in a new epoch in drilling. Even though the equipment is presently very heavy, cumbersome, and expensive, experience is proving that for large diameter water wells in glacial drift at depths of less than 1,000 ft., this method is superior to conventional methods.

The method employs clear water circulated from outside of the drill stem through the bit, drawing the cuttings up through the center of the drill stem, through a gravel pump and into the pit.

Inherent advantages include larger diameter wells at less cost and for less power. These wells have higher yields because clear water is used for drilling fluid. Well completion is expedient because installation of screen and gravel packs is simplified.

This method requires detailed engineering planning. An accurate test well is essential. An electric log of the well provides data about probable yields while the pumping test will give the necessary static water level. This information is useful in predicting the stability of the hole and the amount of water required during drilling.--J. E. Garrison.

3-920. Kunkel, Fred. **TIME, DISTANCE, AND DRAWDOWN RELATIONSHIPS IN A PUMPED GROUND-WATER BASIN: U.S. Geol. Survey, Circ. 433, 8 p., 4 graphs, 3 tables, 1960, 4 refs.**

Several reasonable values are assumed for coefficients of transmissibility and storage of lenticular alluvial deposits. These values when substituted in the Theis nonequilibrium formula as modified by Wenzel give curves from which time, distance, drawdown relationships are estimated.--Auth.

3-921. Hendricks, E.L., and others. **PROGRESS REPORT ON USE OF WATER BY RIPARIAN VEGETATION, COTTONWOOD WASH, ARIZONA: U.S. Geol. Survey, Circ. 434, 11 p., map, 10 graphs, 1960.**

Measurements of streamflow, ground-water levels, and meterological data obtained in a 4.1-mi. reach of the flood plain of Cottonwood Wash, Mohave County, define the use of water by riparian vegetation in that part of the stream valley. The computed evapotranspiration loss during the growing season of 1959 was 175 acre-ft., which represented about 33% of the water that entered the reach. The maximum rate of loss during the season was slightly more than 8 acre-ft. per week, or about 60% of the inflow.

The project reach is divided into 2 parts, an upstream subreach of 2.6 mi. and a downstream subreach of 1.5 mi. Seasonal losses in the upstream and downstream subreaches were 75 and 100 acre-ft. respectively. Losses in the shorter downstream subreach were larger because of the greater plant population.

During the summer of 1960 the vegetation in the lower subreach will be chemically defoliated as a part of the experiment to determine the savings in water losses that can be effected by modifying riparian vegetation. Tests on chemical defoliants indicate that a single spraying eliminates the leaves on cottonwood trees for 7 or 8 days and that no permanent damage results.--Auth.

3-922. Piper, Arthur M. **INTERPRETATION AND CURRENT STATUS OF GROUND-WATER RIGHTS: U.S. Geol. Survey, Circ. 432, 10 p., 1960, 17 refs.**

This paper is concerned with the legal rights of individuals to withdraw water from permeable materials beneath the land surface. It was a contribution to the Water Rights Conference, Michigan State

University, March 1960. The specific topics discussed are: 1) doctrines of ground-water law in relation to hydrologic environments; 2) common-law doctrine; 3) prior-appropriation doctrine; and 4) ground-water rights in the future.--U.S. Geol. Survey.

3-923. Toth, Alfred M. GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF CORY (NO. 344), SASKATCHEWAN: Canada, Geol. Survey, Paper 60-25, 6 p., 2 maps (in pocket), table, 1960, 2 refs.

This report deals with a small area in S.-central Saskatchewan around the city of Saskatoon. No outcrops of bedrock occur. Sands at the base of the Cretaceous contain much salty water. These sands are overlain by Lower and Upper Cretaceous semiconsolidated shales, with fine sand lenses. Drift deposits consist of till, sand, and gravel. Surface sands supply almost all the ground water. Adequate supplies for farm requirements are found at depths of less than 65 ft. Wells that penetrate sand and gravel just above bedrock provide the large amounts of water required in industry. The 10 aquifers studied are described in detail. Quality and potable limits of the water are shown in a table, and 2 maps indicate water probability.--M. Stewart.

3-924. Bond, Robert B., and others. KLAMATH RIVER BASIN INVESTIGATION: California, Dept. Water Resources, Bull. no. 83, 128 p., 14 illus., 25 pls., 82 tables, May 1960.

This report contains an inventory of the surface- and ground-water resources of the Klamath River drainage basin in northern California. It includes estimates of present and probable ultimate water requirements for irrigation, domestic, and industrial use under full development, and presents a master plan for full development of the area.

Ground-water storage in the drainage basin occurs mainly in 3 areas; Butte Valley, Shasta Valley, and Scott Valley. In Butte Valley, the Butte Valley basalt of Quaternary age is the most productive water-bearing formation in the region. Yields of 100 to 1,000 g.p.m. (gallons per minute) for each foot of drawdown have been recorded in the fractured basalt. Sedimentary lake deposits and alluvial fan deposits are generally low in permeability and supply only limited quantities of ground water. In general, ground water is bicarbonate in type and suitable for domestic and irrigation uses except for local areas of hard water and high nitrates. Ground water occurs at depths generally less than 25 ft.

In Shasta Valley, the Pluto's Cave basalt of Quaternary age constitutes the best and most consistent water-bearing formation in the valley. Yields of 100 to 4,000 g.p.m., with an average yield of 1,300 g.p.m., occur in joints and fractures, along the edges of flows, and in debris-filled lava tunnels or tubes. Variable quantities of ground water occur in unconsolidated alluvium and in glacial moraine and outwash deposits. Very limited quantities of ground water occur in metamorphic rocks of pre-Cretaceous age, in sandstones and shales of the Chico formation of Upper Cretaceous age, and in the Umpqua formation of Eocene age. Ground water in these older rock units occurs mainly in structural openings such as joints, fractures, foliation and bedding planes, shear zones and faults. Ground water generally stands at shallow depths and is of low mineral content.

In Scott Valley, unconsolidated Quaternary alluvium supplies all of the local domestic and irrigation needs. A thick section of alluvium, up to 400 ft., yields 1,200 to 2,500 g.p.m. in many wells. Coefficients of permeability range from 600 to 1,200 g.p.m. Ground water occurs at shallow depths and is of low mineral content.--R.C. Richter.

3-925. Dutcher, Lee C., and W.L. Burnham. GEOLOGY AND GROUND-WATER HYDROLOGY OF THE MILL CREEK AREA, SAN BERNARDINO COUNTY, CALIFORNIA: U.S. Geol. Survey, Repts., Open-File Ser., 229 p., 14 pls. incl. maps (5 in pocket), secs., graphs, 18 tables, 1959, 25 refs.

The Mill Creek area, in the upper Santa Ana Valley, is bounded on the N. by the Santa Ana River, on the E. by the San Bernardino Mountains, on the S. by the Crafton Hills, and on the W. by the W. edge of the city of Redlands. Large alluvial fans underlie most of the area, but other landforms include alluvial benches, dissected alluvial hills, plains, terraces, and bedrock hills which locally protrude above the floor of the alluviated valley.

The water-bearing deposits include channel deposits of Recent age, which principally underlie the channels of the Santa Ana River and Mill Creek, younger alluvium of Recent age beneath flood plains and in fans, older alluvium and bench deposits of Pleistocene age, and the San Timoteo beds of Pliocene and early Pleistocene age.

The younger alluvium attains a known maximum thickness of about 140 ft. beneath Mill Creek upstream from the mouth of Mill Creek Canyon; elsewhere in the area it ranges in thickness from a featheredge to about 130 ft. in Mill Creek basin. The older alluvium locally may exceed 800 ft. in thickness; and the San Timoteo beds locally may exceed 2,000 ft., but their thickness and extent beneath the valley areas are imperfectly known.

The virtually nonwater-bearing rocks include the Potato sandstone, which crops out in the San Bernardino Mountains, and crystalline and metamorphic rocks of pre-Tertiary age, which form the bedrock of the area.

Faults strike across the valley area and form barriers that restrict the movement of ground water through all deposits older than those of Recent age. The approximate positions of several ground-water barriers in the area are shown for the first time. Major barriers include the Crafton, Redlands, and Oak Glen faults; in addition, other barriers, believed to be minor faults, subdivide previously established ground-water basins.

Mill Creek is the largest tributary of the Santa Ana River in the Mill Creek area. The flow at the mouth of the canyon where the stream emerges from the San Bernardino Mountains and just downstream from the intake of power canal 1 averaged about 8,700 acre-ft. per year during the periods of record, 1920-1938 and 1948-1955.

A part of the water diverted from Mill Creek is returned to ground water through spreading basins in Mill Creek and Mentone basins each season. During the period of record, 1922-1955, it is estimated that a total of about 170,000 acre-ft., or an average of about 5,000 acre-ft. per year, was conserved in this manner.

Seasonal water-level fluctuations of as much as 50 ft. are recorded in Mill Creek basin; long-term fluctuations in response to wet and dry climatic cycles of as much as 120 to 140 ft. are recorded in Reservoir, Redlands, and Western Heights basins.

Pumping tests were made in Mill Creek basin to determine the coefficients of transmissibility, permeability, and storage of the younger and the older alluvium and the distances to aquifer boundaries.

Recharge to Mill Creek basin occurs principally by seepage from Mill Creek and from artificial spreading basins, subsurface inflow from the mouth of Mill Creek Canyon and from the Triple Falls Creek area, and from deep penetration of rain. Ground water is discharged from the ground-water reservoir of Mill Creek basin principally by pumping and subsurface outflow to Mentone basin; a very small amount is transpired by plants, and infrequently a very small amount discharges as "rising water" in Mill Creek; the latter 2 items were not estimated.

The estimated gross ground-water storage capacity of Mill Creek basin is about 8,000 acre-ft., based on a specific yield of 5% estimated from pumping tests. The estimated usable capacity is about 6,400 acre-ft. In Dec. 1951 only about 2,000 acre-ft. of the usable storage remained in the basin, and in March 1955 about 2,800 acre-ft. of usable storage remained.

Because the usable storage capacity is small, the dependable yield of Mill Creek basin is limited to the supply available during severe droughts. During the 6-year dry period, 1946-1951, the short-term yield was estimated to be 1,600 acre-ft. The short-term yield could be increased substantially by additional water-spreading operations in the eastern part of the basin and by salvage of a part of the subsurface outflow from the basin by drilling supply wells or constructing a collection gallery or a large water tunnel near the western margin of the basin.

The chemical quality of ground water in the Mill Creek area is excellent. The waters are mainly of the calcium bicarbonate type, have about 160 to 230 p.p.m. of dissolved solids, and generally are suitable for agricultural and domestic uses.--From auth.

3-926. Visher, Frank N., and J. F. Mink. SUMMARY OF PRELIMINARY FINDINGS IN GROUND-WATER STUDIES OF SOUTHERN OAHU, HAWAII: U.S. Geol. Survey, Circ. 435, 16 p., 5 maps, 2 diags., 7 graphs, 1960.

Presents findings of a preliminary study instituted to determine the amount of additional ground water that might be developed and the geologic and hydrologic conditions that control the development and use of water. The extent and causes of sea-water encroachments are discussed and illustrated.--U.S. Geol. Survey.

3-927. Kulp, W.K., and H.T. Hopkins. PUBLIC AND INDUSTRIAL WATER SUPPLIES OF KENTUCKY: Kentucky Geol. Survey, Ser. 10, Inf. Circ. 4, 102 p., 3 figs., 13 tables, 1960.

The basic supplies of ground water and surface water remain relatively unchanged while public and industrial development continue to place increased demands upon these supplies. Water resources must be utilized efficiently and judiciously; such use can be based only on adequate knowledge. To this end, ground-water investigations are being conducted by the Ground Water Branch of the U.S. Geological Survey in cooperation with the Kentucky Geological Survey and formerly with the Dept. of Economic Development of Kentucky.

This report presents, with a few exceptions, those supplies using more than 10,000 g.p.d. (gallons per day).--Kentucky Geol. Survey.

3-928. Keech, Charles F. WELLS IN FILLMORE COUNTY, NEBRASKA: Nebraska, Univ., Conserv. & Survey Div., Nebraska Water Survey Paper, no. 8, 39 p., map, diag., graph, table, 1960, 14 refs.

Fillmore County is on the upland loess-covered plains of southeastern Nebraska. It has an area of 576 sq. mi. Sand and gravel and associated silt and clay deposits underlie the area. The parts of these deposits that are below the water table are saturated. The saturated thickness ranges from less than 5 ft. on bedrock ridges to more than 200 ft. on bedrock valleys. In about seven-eighths of the county these deposits will support large-capacity wells. Although in about one-eighth of the county they are too thin to produce large yields, they generally will produce enough water for livestock and domestic supplies. The area where irrigation wells cannot be obtained is in the southeastern part of the county, principally between the towns of Milligan and Ohiowa.

The unconsolidated deposits of sand, gravel, silt, and clay rest on an eroded bedrock surface of sandstone, limestone, and shale. The shale and limestone have little significance as potential sources of ground water, but water can be obtained from the sandstone, although it generally is highly mineralized. The water available to wells in the county is derived principally from precipitation.

Depth to the regional water table beneath the land surface ranges from less than 5 ft. in the valley alluvium of the West Fork Big Blue River to about 100 ft. in the higher topographic areas in the southwestern part of the county. Depths to water of 75 to 95 ft. are typical in most of the upland. In general, the depth to the water table below the land surface decreases to the SE. W. of Martland the depth to water is about 100 ft.; at Grafton, Fairmont, Geneva, and Exeter the depth is 75 to 85 ft.; at Shickley and Strange about 75 ft.; and at Ohiowa about 50 ft. Irrigation wells generally are drilled to penetrate about 50 ft. of the saturated sand and gravel. If the thickness of the sand and gravel is less than 50 ft., the wells are drilled to the bedrock. The depth of irrigation wells ranges from about 60 ft. to 300 ft.

The use of ground water for irrigation has increased greatly since 1952, the greatest increases occurring during the drought period of 1954-1956. There are indications that in some areas water levels are being lowered. The ground water is generally of low mineralization and in most of the county is of calcium-bicarbonate type. The water generally is suitable for irrigation, domestic, and many industrial uses.--From introd.

Table gives the following information for each well: owner or user, year drilled, depth of well, diameter of casing, altitude, static water level, drawdown, yield, use of water.

3-929. Keech, Charles F. WELLS IN HAMILTON COUNTY, NEBRASKA: Nebraska, Univ., Conserv. & Survey Div., Nebraska Water Survey Paper, no. 7, 40 p., map, diag., table, Oct. 1960, 11 refs.

Hamilton County includes an area of about 538 sq. mi. in the southeastern part of the loess-plains region, just W. of the glaciated region. Sand and gravel and associated silt and clay deposits of Quaternary age underlie the area. The parts of these deposits that are below the water table are saturated and yield large quantities of water to wells.

The Quaternary deposits rest on an eroded bedrock surface of rocks of Cretaceous age, except in one small area in the southwestern part of the county where they rest on a remnant of Tertiary deposits. The deposits of Tertiary age are partly consolidated fine-textured sand, silt, and clay. These deposits are saturated and may yield water to some wells. The Cretaceous rocks have little significance as potential sources of ground water in Hamilton County.

The water that is available to wells in the county is derived principally from precipitation; the recharge through the soil is believed to average about 40,000 acre-ft. per year. Some recharge is also obtained from the Platte River when it is in flood stage, but the amount thus received is relatively small compared to that received from precipitation.

The use of ground water for irrigation has increased greatly since 1952, and analyses of the hydrologic data indicate that the ground-water discharge exceeds the recharge. The natural recharge is about equal to the amount of water required to irrigate one-ninth of the land. Development in 1957 had reached the point where almost one-third of the land in the county was being irrigated with ground water.

The ground water is generally of relatively low mineralization and in most of the county is of the calcium bicarbonate type. Near the N. and W. borders of the county, the relatively high mineralization and high concentrations of sulfate in the ground water probably are due in part to recharge from the Platte River. The continued lowering of the water table may cause the more mineralized water in the western part of the county to move into the areas where the water is now the least mineralized. The water is suitable for irrigation, domestic, and many industrial uses.--From introd.

The table gives records of wells in the county, including the following information: owner and user, year drilled, depth of well, type of pump, type of power, diameter and type of casing, description, distance above or below land surface, altitude above sea level, depth to water below measuring point, date of measurement, drawdown, yield, use of water.

12. MINERAL DEPOSITS

See also: Geologic Maps 3-737, 3-742; Areal and Regional Geology 3-762, 3-765; Geophysics 3-831, 3-861; Geochemistry 3-869, 3-891, 3-892; Mineralogy 3-902; Sedimentary Petrology 3-914.

3-930. Springer, Karl J. AVIATION AND THE MINING INDUSTRY: Western Miner, v. 33, no. 3, p. 33-40, 3 figs., 5 pls., March 1960.

The common interest between mining exploration and development and aviation in Canada started early in the 1920's with the formation of such companies as the Ontario Provincial Air Services, Laurentide Air Services, Northern Air Services, and the Patricia Airways and Exploration Co. This establishment of aerial transportation gave a tremendous impetus to mining exploration. Mines found mainly by aerial reconnaissance include Pickle Crow Gold, Opemiska Copper, and Giant Yellowknife. The increasing usefulness of aerial photography and, durthe last 10 years, of airborne geophysical surveys makes them indispensable to modern mining exploration. The development of the helicopter has also been of great benefit, particularly in mountainous country.--J. A. Chamberlain.

3-931. Kelly, William C. CONTACT PRINTING OF DRILL CORES: Econ. Geology, v. 55, no. 6, p. 1303-1305, illus., Sept.-Oct. 1960, 2 refs.

A method is briefly described in which treated photographic paper is held in contact with diamond drill core to reveal the presence and location of certain elements or minerals.--J. A. Chamberlain.

3-932. Leonard, B. F. REFLECTIVITY MEASUREMENTS WITH A HALLIMOND VISUAL MICROPHOTOMETER: Econ. Geology, v. 55, no. 6, p. 1306-1312, 2 tables, Sept.-Oct. 1960, 12 refs.

The Hallimond visual microphotometer has yielded satisfactory results in conjunction with equipment found in many small laboratories. Reproducibility of results may approach 0.1% for measurements in the 5-25% reflectivity range. Precision falls off rapidly with eye fatigue.

Reflectivity of grains about 0.03 mm. in diameter can be measured without change in the usual set-up. Pits and scratches on polished surfaces do not significantly affect reflectivity measurements.--J. A. Chamberlain.

3-933. Witkind, Irving J., and others. ISOPACH MAPPING BY PHOTOGEOLOGIC METHODS AS AN AID IN THE LOCATION OF SWALES AND CHANNELS IN THE MONUMENT VALLEY AREA, ARIZONA: U.S. Geol. Survey, Bull. 1043-D, p. 57-85, 5 illus., 10 maps (2 on pl. in pocket), 2 diags., sec., 1960, 4 refs.

In the Monument Valley area of northeastern Arizona, U-V deposits are localized in strata of the Shinarump member of the Chinle formation of Triassic age that fill ancient scour channels, some of which are along the axes of broad, shallow, elongate troughs known as swales.

Commonly the swales are not visible from the ground but are apparent on isopach maps of selected strata that underlie the Shinarump. To determine whether maps prepared from aerial photographs would be equally useful, a test area previously mapped in the field was mapped by photogeologic methods.

The strata in the interval represented by the isopach maps are distinctive both in the field and on the aerial photographs. Both the base and top of this interval are unconformities. As the unconformity at the base of the interval is smooth and even, however, the isopachs reflect irregularities at the top of the interval, the most prominent of which are the channels and swales at the base of the Shinarump.

Isopach maps made by photogeologic methods were compared with one isopach map and one channel map that were prepared by field methods. The photogeologic isopach maps delineated both the swales and the channels. This suggests that photogeologic methods are adequate for use in defining swales similar to those in the Monument Valley area. Furthermore, photogeologic methods are independent of weather and logistics problems, and can conveniently precede geologic fieldwork. Many isopach readings can easily be taken in a relatively short time. On the other hand, limitations are imposed by the need for aerial photographs from which suitable photogrammetric measurements can be made.

If such photographs are not already available, the cost of obtaining them may be prohibitive. Also, the top and base of the interval to be measured must be discernible on the photographs. Accuracy is reduced where observations are widely spaced or where the top and base are widely separated horizontally.--Auth.

3-934. Perry, J. Kent. **A NEW GEOCHEMICAL METHOD FOR THE DETERMINATION OF MOLYBDENUM IN SOIL AND ROCK:** Econ. Geology, v. 55, no. 6, p. 1232-1243, 4 graphs, 3 tables, Sept.-Oct. 1960, 9 refs.

A new geochemical method for the determination of Mo in soil and rock is given. W, chemically similar to Mo, does not react with the colorimetric reagent. The method can be used without modification for determining a much wider range of Mo than the commonly used thiocyanate method.

The method is based on carbonate-nitrate fusion of the sample and subsequent aqueous leaching, which remove elements that form insoluble hydroxides. A further separation of Mo from interfering elements is effected by solvent extraction with amyl acetate, followed by aqueous stripping. A colored complex molybdenum exanthate compound is formed by the addition of potassium ethyl xanthate, extracted into benzene, and compared with standards. Approximately 30 determinations can be made per man day. The test can be used in a field camp with the use of portable heat sources.

Radiochemical tracer techniques show that 45% of the Mo present in the sample aliquot is recovered as colored complex. This loss, however, is partially or wholly compensated for since standards are subjected to the same procedure. Standard deviation for the method was found to be ± 6.3% error.

The greatest error is caused by incomplete and inconsistent decomposition of silicate materials in the sample. This error appears to be of the same order of magnitude for both the thiocyanate method and the new xanthate method presented in this paper. --Auth.

3-935. Riddell, John E. **GEOCHEMICAL PROSPECTING METHODS EMPLOYED IN CANADA'S GLACIATED PRECAMBRIAN TERRAINS:** Mining Engineering, v. 12, no. 11, p. 1170-1172, 4 tables, Nov. 1960.

Results of a survey taken among 15 Canadian exploration companies as to the geochemical methods employed during 1959 in areas containing glacial debris. Although the companies surveyed indicated varying attitudes toward the effectiveness of geochemical prospecting in such areas, the author concludes that many glaciated Precambrian areas can be satisfactorily prospected for base metals by geochemical methods.--Auth.

3-936. Malyuga, D.P., and A.I. Makarova. **AN EXPERIMENT IN BIOGEOCHEMICAL PROSPECTING OF ORE DEPOSITS IN THE AUTONOMOUS TERRITORY OF TUVA:** Geokhimiya [in translation], 1956, no. 1, p. 109-116, map, 2 tables, pub. 1960, 9 refs.

In order to verify the efficiency of biogeochemical methods of ore prospecting in new parts of the Tuva autonomous region, prospecting work for Ni, Co, and Cu was carried out. It has been established that Ni, Co, and Cu accumulate in the upper humus horizon A and in plants. According to all data the content of these elements in soils and plants of the studied region varies:

1) The content of Co in soils from $1.0 \cdot 10^{-3}$ to $1.1 \cdot 10^{-2}$%; in plants from $1.0 \cdot 10^{-3}$ to $9.0 \cdot 10^{-2}$%;

2) The content of Ni in soils from $2.0 \cdot 10^{-3}$ to $2.0 \cdot 10^{-1}$%; in plants from $1.2 \cdot 10^{-3}$ to $7.0 \cdot 10^{-2}$%;

3) The content of Cu in soils from $1.0 \cdot 10^{-3}$ to $2.0 \cdot 10^{-1}$%; in plants from $2.0 \cdot 10^{-3}$ to $5.0 \cdot 10^{-1}$%;

Using the method of quantitative determination (polarographic etc.) of the Ni, Co, and Cu content in soils and plants, the districts with a high content of these elements have been found and plotted on isoconcentrate maps. A more detailed investigation resulted in finding a Cu lode.

The boundary between 2 metal-bearing zones has been defined according to the content and relation of Co, Ni, and Cu in the upper humus horizon of the soil. On the basis of these data the authors come to the conclusion that the biogeochemical method may be used not only for ore prospecting but also for the detection of hidden tectonic disturbances, faults etc. --Auth.

3-937. Rattigan, J.H. **RESIDUAL CHARACTERISTICS OF CRYSTALLATES GENETICALLY ASSOCIATED WITH ORE DEPOSITS:** Econ. Geology, v. 55, no. 6, p. 1272-1284, Sept.-Oct. 1960, 21 refs.

Ore deposits are specialized products of geochemical differentiation, and a basic assumption in many theories of genesis, whether magmatic, metamorphic, or metasomatic, is that ores are related to crystallization in a source system. The crystallates from which particular ore metals have been fractionated are considered to have a specific geochemical character expressed in features of petrology, mineralogy, and chemistry of the crystallates in mass or in some components. These characteristics may be of value in restricting areas for exploration. The occurrence of some base metals such as Sn, Cu, Pb, Zn, and Cr is discussed in terms of the geochemical character of associated crystallates.--Auth.

3-938. Foley, Lyndon Lyman. **ZONAL ARRANGEMENT OF METALS IN HYPOGENE VEINS IN ARKANSAS:** Econ. Geology, v. 55, no. 7, p. 1551-1553, table, Nov. 1960, 10 refs.

Brief observations are made on mineral zoning in Arkansas, including the Hg area of Pike County and the Sb area of Sevier County. Sulfide distribution in the Bellah mine is such that galena is most abundant above the 115-ft. level and sphalerite and chalcopyrite, successively, most abundant below. The mineralized veins in W.-central Arkansas show zonal arrangement of metals from Hg down to Cu with the Ag zone absent. The possibility of lower zones of Au, As, and Sn may be inferred.--J.A. Chamberlain.

3-939. Searls, Fred Jr. **ISOTOPIC COMPOSITION OF LEAD AND PRECAMBRIAN MINERALIZATION OF THE COEUR D'ALENE DISTRICT, IDAHO:** Econ. Geology, v. 55, no. 7, p. 1565, Nov. 1960, ref.

Discussion of GeoScience Abstracts 2-3085. It is unreasonable to date Coeur d'Alene sediments pre-Ep-archean solely on the basis of isotope work. Evidence of alteration, degree of metamorphism, stratigraphy, and relationship to intrusives should not be discarded in an "ipse dixit" attitude.--J.A. Chamberlain.

3-940. Anderson, Alfred L. GENETIC ASPECTS OF THE MONAZITE AND COLUMBIUM-BEARING RUTILE DEPOSITS IN NORTHERN LEMHI COUNTY, IDAHO: Econ. Geology, v. 55, no. 6, p. 1179-1201, 11 illus., map, Sept.-Oct. 1960, 11 refs.

Deposits of monazite and Nb-bearing rutile in a belt more than 10 mi. long in northern Lemhi County, Idaho, are distinguished by their notable concentrations of such elements as Th, Ti, Nb, Ba, Ca, Fe, P, S, and the rare earths, and by their abundance of carbonates, chiefly calcite. These deposits occur as structurally controlled replacements of crystalline limestones, amphibolites, and porphyroblastic gneisses which form part of the complex metamorphic border zone of the Idaho batholith. Most of the deposits, which are small and tabular, show a sporadic and irregular distribution of minerals, the most abundant of which are actinolite, allanite, apatite, monazite, calcite, barite, ilmenorutile (Nb-bearing rutile), ilmenite, and magnetite. Other minerals, some of them sparse, include biotite, phlogopite, garnet, epidote, glaucophane, ancylite, bastnaesite, sphene, rutile, chlorite, pyrite, pyrrhotite, chalcopyrite, and quartz. Silicates, except sphene, were deposited first and were followed successively by phosphates, carbonates, sulfates, oxides, and sulfides. Most of the Th entered the allanite instead of the somewhat later monazite.

The deposits possess all the compositional characteristics of the carbonatites, but differ from the type carbonatites in their seeming lack of association with alkalic igneous rocks. Although the deposits were regarded by others as replacements of marble beds and as products of metamorphic differentiation, the unique association and concentration of elements so characteristic of the carbonatites, coupled with the paragenetic development, suggests that they, like the carbonatites, are of magmatic rather than of metamorphic origin.--Auth.

3-941. Belt, Charles Banks, Jr. INTRUSION AND ORE DEPOSITION IN NEW MEXICO: Econ. Geology, v. 55, no. 6, p. 1244-1271, 15 maps, graph, 5 tables, Sept.-Oct. 1960, 21 refs.

In the early part of the twentieth century several investigators proposed that hydrothermal ore deposits are precipitated from solutions or fluids that had been separated from deep-seated magmas. The purpose of this paper is to test this concept, studying the primary petrology, hydrothermal alteration, and distribution of Cu and Zn in silicic igneous plutons genetically related (in the Niggli sense) to nearby hydrothermal ore deposits. Silicic Tertiary plutons were chosen in 3 New Mexico mining districts, the Hanover-Fierro intrusive at Hanover and Fierro, the Granite Mountain pluton at Magdalena, and 4 outliers of the Lordsburg intrusive at Lordsburg. The detailed petrographic and alteration study of each sample taken was accompanied by an analysis for Cu and Zn through a newly developed, sensitive, and accurate dithizone technique.

The metal ion distribution of a given metal in an igneous country rock in an area of few veins bearing metals is apt to be related to primary igneous texture, composition, and other features, but is not related to alteration. The average weight percent of alteration in this instance is low, and the amount of metal introduced into the rock from the veins is small. Conversely, the metal ion distribution in an igneous country rock that is cut by numerous veins bearing metals is statistically far more clearly related to alteration than to primary igneous features. The average weight percent of alteration and amount of metal introduced into this area is apt to be large. The same series of relations applies as well on a small scale, for as a single vein is approached from a distance in an igneous country rock, the content of alteration minerals and ore metals increases; both alteration and ore metals are more closely related to each other.

The results of the study raised the question whether the ore deposits of the 3 districts studied actually originated from the adjacent intrusives.--Auth.

3-942. Buckland, F.C. MODERN QUEST FOR THE KLONDIKE LODE: Western Miner, v. 33, no. 10, p. 54-57, 15 pls., Oct. 1960.

In an attempt to locate a mother lode on the divide between Upper Bonanza and Eldorado creeks, Yukon, soil testing over 12 sq. mi. was started in June 1960. Soil samples were taken each 100 ft. along bulldozer cuts, panned, and colors or nuggets recorded. Although practically no outcrops are present in the area, several veins containing free Au were found in the initial cuts.--J. A. Chamberlain.

3-943. Narayanaswami, S., and others. STRUCTURAL CONTROL AND LOCALIZATION OF GOLD-BEARING LODES, KOLAR GOLD FIELD, INDIA: Econ. Geology, v. 55, no. 7, p. 1429-1459, 10 figs. incl. 4 maps, secs., diags., 3 tables, Nov. 1960, 28 refs.

Au-bearing lodes in Kolar Au field localized in Precambrian Dharwar metavolcanics reveal remarkable structural and stratigraphic controls of high-temperature, hypothermal ore deposits. Fifteen parallel lodes including 6 Au-quartz lodes and 9 Au-quartz-sulfide lodes have been mapped. The Champion quartz lode system has been mined over a strike length of 5 mi. and down to an average vertical depth of 9,000 ft., the maximum depth reached to date being 10,200 ft. The sulfide-bearing Oriental and McTaggart lodes have recently been explored and developed in the northern part of the field.

The lodes are localized along stratigraphic contacts between competent beds of granular, fibrous, or massive amphibolite and schistose amphibolite. They consist of en echelon quartz vein-zones in altered and mineralized wall-rock composed of diopside, hornblende, cummingtonite, epidote and biotite, and flanked by thick micaceous-altered wall rock. Besides native Au, the ore minerals include chiefly pyrrhotite, arsenopyrite, galena, pyrite, scheelite, and magnetite.

Payable ore shoots along the lodes are localized in areas of dilation in the vicinity of en echelon cross-folds and associated en echelon faults. Predominantly dextral en echelon pattern of ore shoots showing N. pitch has resulted from dextral cross-folds; these are intervened by sinistral en echelon ore shoots having S. pitch in local areas of sinistral folding. The en echelon nature of quartz vein-zones within lodes reflect the above en echelon pattern of ore shoots and cross-folds on which they are localized.

The future exploration for lodes to augment the declining ore reserves will depend on the diligent application of the above structural principles.--Auth.

3-944. Takahashi, Taro. SUPERGENE ALTERATION OF ZINC AND LEAD DEPOSITS IN LIMESTONE: Econ. Geology, v. 55, no. 6, p. 1083-1115, diags., graphs, 8 tables, Sept.-Oct. 1960, 30 refs.

An attempt is made here to describe occurrences and paragenetic sequences of the supergene Zn and Pb minerals in 3 districts representing varying mean temperatures and humidities. The facts observed in field and laboratory are interpreted in the light of physical chemistry, assuming equilibrium conditions. The stability relationships between smithsonite, hydrozincite, and zinc hydroxide are defined interms of pH and total carbon dioxide concentrations in the aqueous solution system, or of the partial pressure of carbon dioxide in the dry system. The stability fields of hemimorphite and willemite are also discussed. The study explains the common occurrence of hydrozincite in arid regions, and the scarcity of this mineral in humid regions. The common occurrences of smithsonite and hemimorphite in the southern Appalachian district, and the predominance of smithsonite over hydrozincite and hemimorphite in the upper Mississippi Valley district can be explained by the pH of the ground waters and soils. The stability fields of supergene lead oxide minerals, wulfenite, cerussite, anglesite, and Cd minerals are calculated in terms of pH, Eh, and total S concentration or total carbon dioxide concentration in solution. The paragenesis of the Pb minerals and the mobilization of molybdate and Cd ions are discussed. The results of the spectrochemical analyses indicate that Mo and As in the supergene facies were derived from galena, whereas V and P were derived from the limestones and shales.--Auth.

3-945. Fyles, James T. TOBY CREEK. MINERAL KING (SHEEP CREEK MINES LIMITED) (In: British Columbia, Dept. of Mines, Annual Report... 1959: p. 74-89, 2 illus., geol. map, secs., plan, diag., 1960) 3 refs.

The Mineral King Pb-Zn mine, 25 mi. W. of Invermere, British Columbia, has replacement ore bodies in Precambrian dolomite. Argillites, dolomites, and quartzites of the Dutch Creek and Mount Nelson formations are much deformed. The major folds of the area are broken by many faults and, in the central part, the rocks are involved in thrust faults and related drag folds that show a movement of upper side to the E. Correlation of strata through the area is difficult, and the mine geology cannot directly be related to the surface exposures nearby. Three types of fragmental rocks occur: Toby conglomerate, dolomite breccia, and brecciated fine-grained diorite dikes.

The ore zone comprises 4 ore bodies whose form cannot be described or illustrated accurately. Replacements of dolomite by barite, sphalerite, galena, and pyrite form 4 ore bodies within a zone of low plunge to the NW. and a low over-all dip to the SW. The ore in general follows fold structures within the dolomite but is influenced by cross-warps and in places follows faults. Since 1954 the average annual production has been 170,000 tons of ore per year.--M.S. Hedley.

3-946. Fyles, James T. REVELSTOKE. MASTODON (MASTODON ZINC MINES LIMITED) (In: British Columbia, Dept. of Mines. Annual Report... 1959: p. 106-117, 2 illus., geol. map, secs., 1960) ref.

The Mastodon is a partly developed Zn mine on La Forme Creek near Revelstoke. The ore bodies are replacements of calcareous rocks in a succession of isoclinally folded limestones, dolomites, and phyllites. There has been bleaching, silicification, and sericitization. In the mine area no major fold is recognized, but there are numerous isoclinal drag folds, many of which have sheared limbs or pass into strike faults.

Mineralization explored to date is in or close to the strike faults, in folds, or in banding related to cleavage. It occurs in phyllite as well as in limestone and dolomite. Exploration is concerned with faults which rudely follow the foliation and with drag folds which affect rock distribution along the dip of the faults and which directly localize some ore shoots. The structural condition of the rocks in and adjacent to the shear zones was of more importance to sulfide deposition than was the chemical composition.--M.S. Hedley.

3-947. Bush, J.B., and others. THE CHIEF OXIDE-BURGIN AREA DISCOVERIES, EAST TINTIC DISTRICT, UTAH; A CASE HISTORY. PART I. U.S. GEOLOGICAL SURVEY STUDIES AND EXPLORATION, by T.S. Lovering, and H.T. Morris: Econ. Geology, v. 55, no. 6, p. 1116-1147, 3 maps, 2 logs, table, Sept.-Oct. 1960, 28 refs.

The Burgin shaft is in the Chief Oxide area of the E. Tintic district, Utah, and is about a mile E. of any previously known ore bodies; workings from it are currently developing a substantial amount of commercial Pb-Zn ore in several blind ore bodies that lie in folded Paleozoic carbonate rock concealed beneath a blanket of Eocene lava. This area was mapped by Tower and Smith of the U.S. Geological Survey in 1897 and again by Lindgren and Loughlin in 1911, but no detailed work was done until after 1943 when a field party headed by T.S. Lovering began a study of the entire E. Tintic district. The history of the development of exploration concepts is summarized under Historical Summary.

The E. Tintic mining district is in the E.-central part of a N.-trending fault-block mountain range near the eastern margin of the Great Basin; dominant structures of the range are a N.-trending syncline on the W. and a less well exposed anticline on the E. Both folds are cut by an intersecting system of transcurrent strike-slip faults and by minor thrust faults and normal faults of moderate displacement. A strong W.-dipping thrust fault cuts the anticline a short distance E. of the fold axis, but is hidden by Eocene lava throughout the E. Tintic district. The pre-Tertiary rocks range from Lower Cambrian to Upper Mississippian and exceed 7,000 ft. in total thickness; they are dominantly marine limestone and dolomite except for a thick basal Cambrian quartzite. The Tertiary rocks are chiefly dacitic lavas and pyroclastic deposits that are intruded by moderately persistent dikes and irregular bodies of monzonite and quartz porphyry. Nearly all the faulting and folding took place before the extrusion of the lavas on a rugged Eocene erosion surface. At about the time of the intrusion of monzonitic magma, many of the faults in the Paleozoic rock were re-opened and in the overlying lava some fracturing took place which was later accented by hydrothermal alteration.

Most of the ore mined in the E. Tintic district has come from Pb-Zn-Ag replacement bodies in shattered jasperoidized hydrothermal dolomite at the intersection of low angle faults and steep mineralized NE.-trending cross fractures.

The U.S. Geological Survey studies of 1943 to 1957 concentrated on detailed mapping of geology and alteration in the E. Tintic district, together with field and laboratory studies of the relation of alteration to stages of mineralization and ore deposition. Trenching and core drilling were carried on after World War II to aid in interpreting the subrhyolite geology, and the Chief Oxide area was 1 of 4 localities tested by drilling. Study of the fossils, lithology, and alteration shown here in a deep drill core, together with the knowledge of the regional geology, led to an essentially correct interpretation of subrhyolite structure in the strongly discordant underlying Paleozoic rocks in which a mineralized tear fault cuts a strong thrust fault, and to the conclusion that ore stage mineralization was present in substantial amounts in the Paleozoic rocks below the Chief Oxide alteration patch in the quartz latite lava. Subsequent geothermal and geochemical work strengthened this conclusion, and the recent development work of the Bear Creek Mining Company, which sank the Burgin shaft, has shown the presence of Pb-Zn-Ag ore of commercial grade in substantial amount in blind ore bodies below the lava blanket in the Chief Oxide area.--Auth.

3-948. Bush, J.B., and D.R. Cook. **THE CHIEF OXIDE-BURGIN AREA DISCOVERIES, EAST TINTIC DISTRICT, UTAH; A CASE HISTORY. PART II. BEAR CREEK MINING COMPANY STUDIES AND EXPLORATION: Econ. Geology, v. 55, no. 7, p. 1507-1540, 6 figs. incl. maps, secs., graphs, 2 tables, Nov. 1960, 28 refs.**

In 1955 exploration for base and precious metals was undertaken by Bear Creek Mining Company immediately N. of the Main Tintic district, Utah. During the course of this work Bear Creek became interested in the E. Tintic district, primarily as a result of the activities of the U.S. Geological Survey in that area. Data published on the E. Tintic district by the Survey and others were studied and map data made available from various mining companies were compiled. Preliminary economic studies were made to determine the present day value of the type of ore body discovered previously in the district. Encouraging results from these investigations led to the selection of specific targets for exploration. Recommendations for a project program were made and approved. Negotiations were successfully concluded in mid-1956 for a unit lease agreement on lands in the E. Tintic district owned by the Tintic Standard and Chief Consolidated mining companies and their subsidiaries.

Of the targets selected for exploration, the Chief Oxide area seemed to be one of the most prominent. Our preliminary work in the Chief Oxide area corroborated the findings of the U.S. Geological Survey described in Pt. I of this paper [see above]. After careful consideration it was decided to gamble the cost of an exploration shaft in this area for the purpose of providing an underground drilling platform. We also hoped by means of underground workings to establish the existence and nature of the postulated fault.

A limited amount of surface drilling was done prior to shaft sinking in order to locate a shaft site and also to obtain additional information of subvolcanic structure and alteration.

Underground exploration in the Chief Oxide area was started in Jan. 1957. The Burgin shaft was sunk to a depth of 1,100 ft., and by Aug. 1959, lateral development on the 1,050 level totaled 4,721 ft. and underground diamond drilling totaled 15,480 ft.

Results of the work done to date are as follows: a) identification of the sedimentary rock section and an interpretation of the structure in the Burgin mine area; b) discovery by penetration of the previously postulated E. Tintic thrust fault; c) discovery of large zones of manganese oxides and carbonates, which were found to be closely related to Ag-Pb-Zn mineralization; d) discovery of ore-grade Pb-Zn mineralization within the footwall rocks of the E. Tintic thrust; e) discovery of high-grade Ag-Pb ore within the thrust zone.

Insofar as ore localization is concerned, the most important structural feature in the Burgin mine area is the E. Tintic thrust fault - a fact that opens up new ore potential over a large part of the E. Tintic district not previously explored.

Although the discoveries to date must be attributed essentially to the application of geology to exploration, the tools of geochemical prospecting and geophysics were also used, and the geochemical work, in particular, was found to be a definite aid in the selection of areas for further exploration.--Auth.

3-949. Carr, J.M. **PORPHYRIES, BRECCIAS, AND COPPER MINERALIZATION IN HIGHLAND VALLEY, B.C.: Can. Mining Jour., v. 81, no. 11, p. 71-73, 4 illus., Nov. 1960, ref.**

The Cu deposits in Highland Valley, British Columbia, include 2 main types, bornite-chalcopyrite lodes of small tonnage and chalcopyrite-bornite disseminations of large tonnage. Work is now progressing on one of the disseminated deposits containing approximately 1% Cu. Initial production is expected to be on the scale of 3,000 tons per day.

Highland Valley is in the center of the early Mesozoic Guichon batholith, a body of quartz diorite which has been repeatedly intruded by later igneous rocks. Among the later intrusives are a granodiorite porphyry stock and a dike swarm which occupy the area of the Cu deposits. Explosion breccias along the porphyry contact and a complex of fractures have significant structural relation to the ore.

Mineralization at the main deposit under study followed at least 2 post-breccia phases of porphyry intrusion, the last of which was associated in time with introduction of orthoclase and with silicification, sericitization, and argillic alteration. Development of tourmaline, fibrous amphiboles, biotite, sodic feldspar, epidote, chlorite, calcite, and zeolites, is also associated.--W.C. Peters.

3-950. Tweto, Ogden. **SCHEELITE IN THE PRECAMBRIAN GNEISSES OF COLORADO: Econ. Geology, v. 55, no. 7, p. 1406-1428, 2 maps, 4 tables, Nov. 1960, 26 refs.**

Scheelite of Precambrian age has been found at several localities in Colorado and Wyoming in recent years. Most of it is disseminated in regionally metamorphosed rocks, principally in calc-silicate gneiss, but also in amphibolite. Small amounts are found in pegmatites and in Au-or Cu-quartz veins of Precambrian age. The scheelite in most of the deposits contains Mo, and much of it is accompanied by discrete powellite ($CaMoO_4$).

The scheelite deposits vary in age with the rocks that contain them and show no consistent genetic associations. Many of the deposits are products of some phase of the major plutonic stage that included regional metamorphism, migmatization, and emplacement of syntectonic granites. A few deposits may be related to younger Precambrian granites, and some are related to late diorite and pegmatite. W originally present in minor concentration in the sedimentary rocks that gave rise to the gneisses was evidently redistributed and recrystallized through successive Precambrian plutonic episodes. Reworked Precambrian deposits may have been a source of the W in the economically important Tertiary deposits, and possibly also of Mo.

The Precambrian scheelite deposits found thus far have proved to be of minor economic importance, but others are still being found, and many more can be presumed to exist; among these may be some of importance.--Auth.

3-951. Sainsbury, Cleo L. METALLIZATION AND POST-MINERAL HYPOGENE ARGILLIZATION, LOST RIVER TIN MINE, ALASKA: Econ. Geology, v. 55, no. 7, p. 1478-1506, 20 figs. incl. 8 illus., 5 maps, sec., diag., 2 tables, Nov. 1960, 63 refs.

The Lost River Sn and W deposit occurs in a buried granite pluton and in associated rhyolite dikes that intrude Paleozoic limestone. The dikes and parts of the granite were greisenized and then argillized irregularly. Metallization accompanied greisenization rather than argillization, although both processes probably were closely related in time.

Fe-Zn ratios in sphalerite indicate that the ore minerals were deposited at a temperature between 425°C. and 740°C. This temperature is within the range of the temperatures at which topaz, a common associate of the ore minerals, has been synthesized in the laboratory. The temperature of deposition of the ore minerals is above the temperature interval in which clay minerals are stable. Thus, clay minerals could not have formed while ore was being deposited. As temperatures fell and entered the stability range of the clay minerals, argillic alteration encroached upon greisen ores and wall rocks.

Reaction rims between quartz and topaz indicate that kaolinite could have formed according to the following reaction:

$$\begin{array}{lllll} \text{topaz} & + \text{ quartz} & + \text{ water} & + \text{ limestone} & \rightarrow \\ (Al,F)_2SiO_4 & + SiO_2 & + 3H_2O & + CaCO_3 & \rightarrow \end{array}$$

$$\begin{array}{lll} \text{kaolinite} & + \text{ fluorite} & + \text{ carbonic acid} \\ Al_2Si_2O_5(OH)_4 & + CaF_2 & + H_2CO_3 \end{array}$$

The clay minerals, which formed from diverse rock types, consist of kaolinite, dickite, mixed-layered chlorite-montmorillonite, and minor montmorillonite, accompanied by variable amounts of muscovite and zinnwaldite. The dickite is most common in and near late veins that cut the earlier-formed greisen.

Temperature is believed to be the principal agent governing the relations between ore deposition and argillization. Similar relations are to be expected in other high-temperature deposits where abundant veining and fracturing indicate that wall rocks reached an isothermal condition above a maximum temperature of 480°C. during ore deposition.--Auth.

3-952. Foley, Lyndon Lyman. SELENIUM, RUBIDIUM, AND YTTRIUM IN MINERAL VEINS IN ARKANSAS: Econ. Geology, v. 55, no. 7, p. 1553-1554, Nov. 1960, 5 refs.

Nine sulfide samples were collected from the Ouachita mountain area and assayed for Se. The only assay above trace was 0.062% from galena from the Davis mine in Sevier County. A chalcopyrite sample from the Bellah mine showed traces of Rb and Y.--J. A. Chamberlain.

3-953. Davidson, C.F. THE MINERALIZED CONGLOMERATES OF BLIND RIVER: Econ. Geology, v. 55, no. 7, p. 1561-1565, Nov. 1960, 11 refs.

Reply to discussions by Roscoe (GeoScience Abstracts 2-1254) and Robertson and Steenland (GeoScience Abstracts 2-2409). Regionally distributed orange monazite in Huronian sediments contains about 0.3% U_3O_8 and shows ages in keeping with a detrital origin (2,500 m.y.). U-rich monazite, usually gray, contains 0.95% to 2.9% U_3O_8 and is probably of epigenetic origin. Future geochronological studies should establish this.

A radial distribution pattern of changing ThO_2:U_3O_8 ratios is wholly inexplicable on the grounds of placer theory, but is quite in keeping with hydrothermal zoning. Robertson and Steenland's report that ThO_2:U_3O_8 ratios increase southwards through Ontario is contradicted by the author's observations and by those of Roscoe.

Huttonite, the monoclinic form of $ThSiO_4$, not thorite, is isostructural with monazite.

Several hundred chemical assays of heavy concentrates are available from many different sedimentary environments that show Th in constant excess of U in modern sands and gravels.

Roscoe's assertion that there is no evidence in the bankets of any gangue mineral or significant trace elements also merits examination. Is the 10 to 12% pyrite in the reefs not a gangue mineral? What are Cu, Co, Mo, W, etc. present in the reefs but trace elements? Other than the relative abundance of pyrite, is there any important geochemical difference between the bankets and hydrothermal uraninite lodes of, say, British Columbia?--J. A. Chamberlain.

3-954. Eastwood, G.E.P. MAGNETITE IN LODESTONE MOUNTAIN STOCK: (In: British Columbia, Dept. of Mines, Annual Report...1959: p. 39-53, 4 maps, 1 table, 1960) 2 refs.

The Lodestone Mountain stock, 15 mi. W. of Princeton, British Columbia, is an ultramafic body composed chiefly of pyroxenite but including peridotite-dunite and pyroxene syenite, diorite, and gabbro. It intrudes rocks of the Triassic Nicola group. Appreciable amounts of magnetite occur in pyroxenite as disseminated grains and as small lenses and veinlike bodies. Two areas of higher than average concentration of magnetite are on Lodestone Mountain and on Tanglewood Hill, 2 mi. to the N. Investigational procedures and sampling results are given.--M.S. Hedley.

3-955. Macdonald, R.D. IRON DEPOSITS OF WABUSH LAKE, LABRADOR: Mining Engineering, v. 12, no. 10, p. 1098-1102, 3 maps, secs., profiles, Oct. 1960, 4 refs.

The history of exploration and a study of the geology and stratigraphy of the Carol Lake-Wabush Lake area of the Labrador-Ungava trough is coupled with detailed information of exploration methods used by the Labrador Mining and Exploration Co. since 1949. The Fe formation in the Wabush Lake area is considered to be the southern but more highly metamorphosed extension of the Fe formation of the trough. The success of gravimetric surveys at one specific deposit in the area, Wabush no. 3, is detailed.--Auth.

3-956. Espenshade, Gilbert H., and Donald B. Potter. KYANITE, SILLIMANITE, AND ANDALU-

SITE DEPOSITS OF THE SOUTHEASTERN STATES: U.S. Geol. Survey, Prof. Paper 336, 121 p., 58 figs. incl. illus., maps, secs., chart, diag., 11 pls. (in pocket), 12 tables, 1960, 162 refs.

The major deposits of kyanite, sillimanite, and andalusite in the southeastern states are in quartzose rock and micaceous schist and gneiss; the Al_2SiO_5 minerals also occur in quartz veins, pegmatites, residual soils, and placers. The kyanite-quartz deposits are the richest and were studied more thoroughly than the other types, particularly in the Farmville district, Virginia, and the Kings Mountain district, North Carolina-South Carolina. Sillimanite-quartz deposits are small and are found only in the Kings Mountain district, North Carolina-South Carolina. Andalusite, and also topaz, occur in some pyrophyllite-quartz deposits of North Carolina and South Carolina. Kyanite is present in micaceous schist and gneiss in large areas of the Blue Ridge of North Carolina and Georgia. Sillimanite occurs in schists in a belt in the western Piedmont extending from North Carolina to eastern Georgia, and also in the Blue Ridge. Probably all deposits of kyanite and sillimanite in micaceous schist and gneiss were formed by the metamorphism of aluminous sedimentary rocks, but only some of the quartzose deposits of Al_2SiO_5 minerals are believed to have been formed in this manner; other quartzose deposits seem to have been formed by hydrothermal alteration of volcanic rocks.

All U.S. production of kyanite since 1950 has come from mines in kyanite-quartz deposits at Baker and Willis Mountains, Virginia, and Henry Knob, South Carolina. Reserves of kyanite-quartz rock (containing 10 to 30% kyanite) in all the southeastern deposits are estimated to be 100 million tons. Kyanite and sillimanite schist and gneiss occur in much larger quantities, but rarely contain more than 10% of the Al_2SiO_5 minerals.--G.H. Espenshade.

3-957. Corey, Allen F. **KYANITE OCCURRENCES IN THE PETACA DISTRICT, RIO ARRIBA COUNTY, NEW MEXICO:** New Mexico, Bur. Mines & Mineral Resources, Bull. 47, 70 p., 11 figs., 9 pls., Dec. 1960, 39 refs.

The kyanite deposits occur on and near La Jarita Mesa, a SE. prong of the San Juan Mountains. The major deposits comprise lenses of kyanite schist within the Precambrian Petaca schist series, which is composed mainly of quartzites and quartz-mica schists with intercalated metavolcanic rocks. Each lens of kyanite-bearing rock is enclosed in a shell of sericite schist, which in turn grades outward into quartz schist and thence into quartzite.

The dominant structural feature is a succession of large isoclinal folds with axes that strike and plunge northwestward and are overturned to the NE. Numerous small folds, foliation, minor crenulations, and joint sets are superimposed within the larger structural features.

The masses of kyanite schist were produced mainly by progressive metamorphism of pelitic silt lenses. Quartz-rosette kyanite rocks were formed toward the end of the metamorphic period. Later hydrothermal solutions deposited quartz-kyanite veins along joints in the kyanite schist.

The favorable economic features are: 1) kyanite schist of apparent commercial grade, 2) moderate tonnage of exposed ore and potentially large ore reserves, and 3) scrap mica as a possible byproduct from the sericite schist. An unfavorable factor is the isolated location of the deposits with respect to railroads and markets.--Auth. and F.E. Kottlowski.

3-958. Font-Altaba, M., and J. Closas M. **A BAUXITE DEPOSIT IN THE PALEOZOIC OF LEON, SPAIN:** Econ. Geology, v. 55, no. 6, p. 1285-1290, illus., graph, 2 tables, Sept.-Oct. 1960, 25 refs.

The recent discovery of a bauxite deposit in Portilla de Luna, province of León, Spain, in the Paleozoic, differs from other Spanish deposits. Its mineralogy, geology, and origin is therefore of interest.

A chemical analysis of an average sample gives the following composition: Al_2O_3 47.9%, SiO_2 15.4%, Fe_2O_3 0.3%, CaO 1.3%, MgO 0.4%, weight loss at 800°C. 36.5%.

The minerals present, identified by X-rays and differential thermal analysis, are gibbsite (54–58%) and halloysite (32–38%).

The deposit lies in middle Devonian, Eifelian sup., and is considered to have been formed by laterization of clays through the combined action of microorganisms and a humid climate. Later metamorphic action produced partial crystallization of the material. Similar deposits occur in Iss and Serov in the middle Urals (U.S.S.R.).--Auth.

3-959. Hartman, James A. **TITANIUM MINERALOGY OF CERTAIN BAUXITES AND THEIR PARENT MATERIALS:** Econ. Geology, v. 55, no. 6, p. 1313-1314, Sept.-Oct. 1960, 3 refs.

A summary of a personal communication from M. Fleischer that discusses several points made in a paper by J. A. Hartman (GeoScience Abstracts 2-444). --J. A. Chamberlain.

3-960. Pirkle, E.C. **KAOLINITIC SEDIMENTS IN PENINSULAR FLORIDA AND ORIGIN OF THE KAOLIN:** Econ. Geology, v. 55, no. 7, p. 1382-1405, 8 illus., map, sec., 2 tables, Nov. 1960, 18 refs.

Thick sections of kaolinitic sediments occur in the Lake Wales ridge area of peninsular Florida. These materials, usually referred to as the Citronelle formation in the published literature, consist largely of quartz sand and gravel with a binder of kaolinite. In exposures the sediments often can be divided, from the surface downward, into 3 zones: 1) loose surface sands, 2) red and yellow clayey sands, and 3) white clayey sands. In much of western Putnam County, the present mining area, the loose surface sands have resulted from weathering and erosion of the kaolinitic sediments. The color of the reddish zone is due to oxidation above the water table of Fe compounds. Throughout large areas the kaolin-bearing sands rest unconformably on the middle Miocene Hawthorne formation. On the eastern side of the Lake Wales Ridge, the kaolinitic sediments in some localities overlie shell marls of late Miocene or younger age.

Present data indicate that kaolinitic clay generally is more abundant in the lower part of the formation. This portion of the formation is close to the surface in parts of Clay, Putnam, Marion, Lake, and Polk counties. In areas where the Lake Wales ridge is highest, for example in Polk County, the lower part of the formation can be found outcropping or close to the surface on the sides of the ridge and in low areas of the ridge crest. The kaolinite is believed to have been deposited as sedimentary clay in an alluvial environment rather than having been derived from the weathering in situ of feldspar sand or some clay mineral.--Auth.

3-961. McGrain, Preston. A HIGH-REFRACTORY CLAY IN HART COUNTY, KENTUCKY: Kentucky Geol. Survey, Ser. 10, Inf. Circ. 5, 10 p., 1960, 3 refs.

Preliminary field investigations and laboratory analyses of clay deposits in the vicinity of Bonnieville, Hart County, indicate a material that has a potential market for the manufacture of high-heat duty and super duty refractories. Deformation temperatures between cones 32 and 37 were observed. --Kentucky Geol. Survey.

3-962. Williams, E.G. RELATIONSHIP BETWEEN THE STRATIGRAPHY AND PETROGRAPHY OF POTTSVILLE SANDSTONES AND THE OCCURRENCE OF HIGH-ALUMINA MERCER CLAY: Econ. Geology, v. 55, no. 6, p. 1291-1302, 2 illus., map, sec., 3 diags., graph, 2 tables, Sept.-Oct. 1960, 8 refs.

Stratigraphic and petrographic study of 32 sections of the Mercer and Connoquenessing formations [Pennsylvanian] in western Pennsylvania has shown that certain consistent relationships exist between the presence or absence of high-alumina Mercer clay and the stratigraphy and petrography of underlying outcropping sandstones. In sections where flint or diaspore clays are present, the clay is underlain by 0-150 ft. of fine-to-medium-grained, very light-gray lower Connoquenessing sandstone. In sections where plastic clay or silty claystone occur below the Mercer coal, the clay is underlain by 20-150 ft. of fine-grained to conglomeratic, medium-light-gray upper Connoquenessing sandstone. The distribution of the high-alumina clay is believed to be related to ancient topographic highs where flint clay was deposited directly on the lower Connoquenessing sandstone. The upper Connoquenessing sandstone was deposited in adjacent topographic lows, while the flint clay still present on the topographic highs was leached to form diaspore. Areas where the upper Connoquenessing sandstone is thin or absent would be the most favorable regions for further prospecting for high-alumina Mercer clay in western Pennsylvania.--Auth.

3-963. British Columbia, Dept. of Mines. ANNUAL REPORT FOR THE YEAR ENDED 31ST DECEMBER 1959: 69, 303 p., 18 illus., 32 figs. incl. maps, secs., tables, Victoria, 1960.

The Annual Report records salient facts in the progress of the mineral industry, also much detail about individual operations, including those undertaken in the search for, exploration of, and development of mineral deposits, as well as the actual winning of material from mineral deposits. An introductory section, separately paged, deals with a review of the mineral industry for 1959 and statistics and departmental work. It also contains notes dealing briefly with work of the Surveys and Mapping Branch, Dept. of Lands and Forests, and with activities of the federal Dept. of Mines and Technical Surveys of interest to the mineral industry of British Columbia.

The introductory section is followed by sections dealing with lode metals; reports on geological, geophysical, and geochemical work; placer; structural materials and industrial minerals; petroleum and natural gas; inspection of lode mines, placer mines, and quarries; coal; inspection of electrical equipment and installations. A table listing the properties described, in geographic groupings, precedes the index.--From introd.

Four papers in the lode metals section of the report are separately abstracted, 3 in the Mineral Deposits section and 1 in the Areal and Regional Geology section of this issue of GeoScience Abstracts.

3-964. U.S. Bureau of Mines. MINERALS YEARBOOK 1959: 3 v., graphs, tables, Washington, D.C., 1960, refs.

Vol. 1 includes chapters on metal and nonmetal mineral commodities except mineral fuels; also a chapter reviewing these mineral industries, a statistical summary, chapters on mining and metallurgical technology, employment and injuries, technologic trends. Vol. 2 includes chapters on each mineral fuel, employment and injuries, and a chapter summarizing developments in the fuel industries. Vol. 3 contains chapters covering each of the 50 states, island possessions in the Pacific Ocean, the Commonwealth of Puerto Rico, and island possessions in the Caribbean Sea, including the Canal Zone. It also has a statistical summary chapter and a chapter on employment and injuries.--From foreword.

3-965. Mullen, D.H., and Allen F. Agnew. THE MINERAL INDUSTRY OF SOUTH DAKOTA IN 1959: South Dakota, State Geol. Survey, Minerals Rept. 7, 12 p., graph, 7 tables, Nov. 1960, ref.

The mines, quarries, and wells in South Dakota produced mineral products valued at $48.5 million in 1959, a 17% increase over 1958 and a new record. The previous high was $42.3 million in 1956. The value of all nonmetals, except scrap mica, Li minerals and lime, increased substantially over 1958. As a group, the nonmetallic minerals represented 56% of the value of the total state mineral production. The quantity and value of sheet mica was more than double that of 1958. Decreases were recorded in the value of Be concentrate and Ag. Au production increased a modest 1%, whereas the value of produced U ore increased 14%. Mineral fuels, coal and petroleum, represented only 1% of the value of the state mineral production. However, value of coal production was 13% greater and that of petroleum more than double that of 1958.--From auth.

Mineral commodities are reviewed under nonmetals, metals, and mineral fuels. A review by counties concludes the report.

13. FUELS

See also: Geologic Maps 3-719, 3-721, 3-735, 3-738, 3-739, 3-742; Areal and Regional Geology 3-748, 3-775; Stratigraphy 3-796, 3-797; Paleontology 3-800; Geophysics 3-825, 3-832, 3-833; Mineral Deposits 3-963, 3-964, 3-965.

3-966. Schurr, Sam H., and others. ENERGY IN THE AMERICAN ECONOMY 1850-1975, AN ECONOMIC STUDY OF ITS HISTORY AND PROSPECTS: 774 p., 73 figs. incl. maps, graphs, 120 tables, Baltimore, Maryland, published for Resources for the Future, Inc., by Johns Hopkins Press, 1960, refs.

This comprehensive study of energy's role in the

United States economy provides a background for answers to questions on fact and policy, such as the likely patterns of energy supply and demand in 1975, the relation between energy use and economic growth in this country and implications it carries for the future, and the meaning of the nation's change in recent years from a net exporter to a net importer of mineral fuels.

Pt. 1 is an analytical history of the more than a century in which fuel dominance shifted from wood to coal and from coal to oil and gas, and which saw the rise of electrification. Pt. 2 is an assessment of future demands for energy, built up from a detailed analysis of consumption within sectors and activities, such as households, transportation, and industry. Pt. 3 assesses future energy supply and presents the estimates against the background of a comprehensive survey of all recent estimates of the reserves and resources of the specific energy sources, coal, oil, gas, and hydropower. This treatment provides a basis for evaluating future prospects for atomic and solar energy and other possible new sources on which explicit data are either scanty or nonexistent.--L.M. Dane.

3-967. Schackne, Stewart, and N. D'Arcy Drake. OIL FOR THE WORLD: 2d rev. ed., 140 p., illus., maps, diags., graphs, New York, Harper & Brothers, 1960.

This book's purpose is to give the general reader a brief introduction to the basic facts about oil and natural gas. The present edition represents a complete revision of the text (first published in 1950), with some new material and with new illustrations. These changes became necessary because there have been rapid changes in the industry. The major contributions of oil to human welfare and to world economy are reviewed. The fundamentals of petroleum geology and petroleum engineering are presented in nontechnical language. Chapters are included on energy from oil, oil formation, history of exploration, present exploration, drilling, production, transportation, refining, and research. All the important phases of the industry are covered, including the geographical locations of oil-producing areas, the conservation of oil as a major natural resource, the essential facts about tankers, pipelines, and oil barges, and the elements of distribution and marketing.--L.M. Dane.

3-968. Iskenderov, M.A. SOME PROBLEMS OF PLANNING A PROGRAM OF DEVELOPMENT OF OIL AND GAS FIELDS: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 91-96, 1959, pub. 1960.

The paper emphasizes the need of a close cooperation between scientists and engineers in all stages of exploration and exploitation. Especially in the case of large fields the planning of exploitation should be made in successive phases to allow for the necessary modifications of the exploitation scheme in order to increase the efficiency of the operations.--C. Voûte.

3-969. MOST WILDCATS ARE LOCATED BY GEOLOGY: Petroleum Week, v. 11, no. 5, p. 16, 18, 3 graphs, Aug. 5, 1960.

A restudy of exploration methods used in the U.S. shows that more than half of the successful wildcats drilled in the past 12 years were based on geology alone. The new study made by B.W. Blanpied, chairman of the American Association of Petroleum Geologists' Committee on Statistics of Exploratory Drilling, is based on the location of new field wildcats. Roughly 25% of the successful wildcats in the 12-year period were located by geophysical methods alone and some 20% with geology and geophysics combined. While geophysics still shows the highest success percentage of wells located on a technical basis, the trend is towards the use of geology. Blanpied believes that this "is due to exploratory thinking that most potentially productive areas were already covered by a geophysical tool or tools, and to the relatively high geophysical cost per barrel of oil."--C.C. McFall.

3-970. Roy, Amalendu. WANTED - A NEW APPROACH TO OIL HUNTING: Petróleo Interamericano, v. 18, no. 10, p. 46-52, Oct. 1960, refs. Text in Spanish and English.

Reviewing the current situation, the author says new and direct methods for oil finding must be developed. Far from being impossible, this is in line with past history because several geophysical tools now commonplace would have seemed impossible a few years ago. He focuses attention on geochemical methods, the radioactive halo approach, the Sandex and Longcolog methods and even some variations on familiar seismic methods although chances of direct oil indication by seismic methods are rated as slim.--Worldwide Oil and Gas Abstracts, v. 5, no. 6, p. 22, Nov.-Dec. 1960, abs. 56-8-11.

3-971. GEOCHEMISTRY TO GET FULL-FLEDGED TEST AS EXPLORATION TECHNIQUE: Petroleum Week, v. 11, no. 22, p. 34-35, 2 maps, Dec. 2, 1960.

A new firm, Davidson Geochemical Oil Co., formed to conduct petroleum exploration and development primarily on the basis of geochemistry, will begin operations soon on the upper Texas Gulf Coast. Initial activity will involve 850,000 acres on which are located some 85 geochemical anomalies. The hope is that some of these anomalies will result in the discovery of major fields. The company's formation underscores the continuing interest - though not necessarily the complete acceptance - within the industry of geochemical exploration methods.

Geochemistry's advocates point to a number of claimed successes for the technique, although the industry generally doesn't credit geochemical analysis for these discoveries. Among the more striking specific examples cited for geochemistry are the Sojourner pool, Haskell County, Texas, and the Heidelberg pool, Jasper County, Mississippi.

Meanwhile, in the U.S.S.R., the attitude toward geochemistry seems to be much more favorable than in the U.S. The evidence available indicates that Russian oil hunters are using geochemical methods effectively.--C.C. McFall.

3-972. Alekseev, F.A., and others. USE OF THE TRITIUM ISOTOPE OF HYDROGEN IN DEVELOPMENT OF OIL FIELDS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1039-1043, map, 2 diags., 3 graphs, 1958, pub. 1960.

Discusses experiments made in using tritium as a marker of water injected for maintaining formation pressure in an oil field. Measuring technique, electrolytic enrichment, dissociation technique, and setup of the field experiment in 2 injection wells surrounded by several production wells of the October oil field of the Grozny area, U.S.S.R., are described. The rate of movement of the tritium-marked water to several observation wells has been recorded and the influence of the influx of natural waters and from other injection wells noted on the interval between waves of radioactivity. Mention is also made of the degree of dilution caused by diffusion and mixing with other waters. It is concluded that tritium is the only really effective medium for investigation of the movement of formation water.--C. Voûte.

3-973. Martin, Rudolf. **PALEOGEOMORPHOLOGY IN CANADIAN EXPLORATION: Oilweek, v. 11, no. 36, p. 85-94, Oct. 22, 1960, refs.**

Hydrocarbons may be trapped either directly or indirectly due to paleogeomorphological processes. Both types of traps may occur either below the morphological surface or above (against it). Several examples of types of geomorphological traps are given. An area in southeastern Saskatchewan is used as an example in working out the rules which govern the formation of ancient landscape forms.--Worldwide Oil and Gas Abstracts, v.5, no. 6, p. 22, Nov.-Dec. 1960, abs. 56-8-8.

3-974. BASEMENT ROCKS HAVE OIL POTENTIAL: Petroleum Week, v. 11, no. 18, p. 24, 28, 29, sec., Nov. 4, 1960.

Oil deposits in basement rocks should be hunted systematically "in suitable areas," says a team of Michigan University geologists. Kenneth K. Landes, and 4 of his advanced students maintain that such accumulations of oil "are not freaks, to be found solely by chance." The 4 essentials for an oil pool - source, reservoir rock, seal, and trap - are present in all of basement rock pools discovered so far. The traps are most likely to be convex upward anticlines or pseudo-anticlines. All known basement rock accumulations occur where the basement rock is at a higher elevation than the surrounding flanking sediment, they report. The 3 possible sources suggested are: 1) overlying organic rock, from which the oil was expelled downward during compaction; 2) lateral, off-the-basement but topographically lower organic rock from which oil was squeezed into an underlying carrier bed through which it migrated updip into the basement rock; and 3) lower lateral reservoirs from which earlier trapped oil was spilled due to tilting or to overfilling.

Most oil-field basement rocks are crystalline and brittle, so that "invariably and inevitably" such rocks are fractured. Most basement rock oil accumulations have been found by accident, they report, but there have been some outstanding exceptions. The La Paz and Mara oil fields of western Venezuela were found by systematic exploration based on geologic findings. At least 5 pools in California produce from basement rocks. In Kansas, all of the oil fields which currently produce from basement rocks lie on the central Kansas uplift. There are at least 8 oil fields in NW. Morocco that produce from fractures in basement rock.--C. C. McFall.

3-975. OIL MAY BE FOUND IN ANY TYPE ROCKS: Petroleum Week, v. 11, no. 26, p. 26, 29, 30, 4 diags., Dec. 30, 1960.

H.M. Zenor, professor of geophysics at the Missouri School of Mines at Rolla, believes that oil and gas accumulations may exist in any type of rock - even fractured basement complexes. He suggests that hydrocarbons have been generated continuously in all oceans of the world throughout geologic time, and that convection currents of percolating sea water, driven by pressures resulting from the temperature differential known to exist between land masses and oceans, not only transfer hydrocarbons but also mineral matter. The dissolving of mineral matter by the circulating sea water from the ocean floor thins the oceanic crust, and its reprecipitation within the continental blocks thickens the continental crustal blocks. The circulating water is believed to lose much of its dissolved load as it rises toward the land surfaces, to mix with meteoric water near the surface, and then to come out and flow back to the sea. Zenor suggests that this mechanism also causes the tensional faults predominating in the ocean floors and the compressional faults predominating in the continental blocks. He depicts stages in the development of this faulting.--C. C. McFall.

3-976. STUDY INDICATES OIL IS FORMING TODAY: Petroleum Week, v. 12, no. 4, p. 20, 23, Jan. 27, 1961.

Using an electron microscope, U. Grant Whitehouse, a consultant to Texas A. & M. College's Department of Oceanography and Meteorology, and his co-workers find that certain types of clay minerals during a settling process pick up organic matter floating in saline water. There ensues a chemical and physical change of the clay minerals that could "manufacture" petroleum. One such diagenetic change was the conversion of a small percentage of available montmorillonite to a chlorite form, and, simultaneously, a change toward an illite-like material, with a gain of free silica, in a simulated marine environment. Such diagenetic changes of clay minerals seem related not principally to the depth of water but to the chemistry of the water, weather, biological factors, and other influences.

If petroleum formation is, as the study suggests, related to the diagnetic changes of clay minerals, then further study of such changes in the laboratory and of the clay minerals associated with producing horizons should aid future exploration.--C. C. McFall.

3-977. Maksimov, S.P., and others. **REGULARITIES OF CHANGE OF COMPOSITION OF CASING-HEAD GASES ALONG THE STRATIGRAPHIC SECTION: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 59-67, 2 diags., 3 tables, 1959, pub. 1960.**

The study is based on analyses of 200 samples of gas from various fields, using the very sensitive chromotographic gas analyzers. The age of the gases varied from Tertiary to Devonian. The change of composition of the gases with increasing age shows a definite trend and corresponds to a change in specific gravity of the oil with its stratigraphic position. This confirms theories on secondary alteration of oil. The thermodynamic theory of alteration however does not cover all aspects of the process. Kinematic factors and chain processes also must be taken into account. It is concluded that gas and oil are the result of one and the same process, although the observed regularities advocate many cycles of oil formation to have taken place with subsequent alteration with time of the oil and gas.--C. Voûte.

3-978. Erofeev, N.S., and V.G. Vasilev. INTENSIFICATION OF EXPLORATION FOR NEW GAS FIELDS: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-A, p. 9-13, 1959, pub. 1960.

In the period 1959-1965 the production of gas in the U.S.S.R. must reach 150 billion cu. m., which is 5 times the production of 1958. A vast gas-supply system will be constructed including 40 main-line gas pipelines with an over-all length of about 26,000 km., connecting the major production and industrial areas. New major gas fields have been discovered in the Caucasus, the Ukraine, the Volga-Ural areas, and in Siberia. Moreover a new extremely rich gas province is being developed in Central Asia in the Bukhara-Khivin area. The overall forecast reserves of gas are estimated at 19 to 20 trillion cu. m.--C. Voute.

3-979. Veber, V.V., and A.I. Gorskaya. ALGARITES OF AZERBAYDZHAN: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 68-70, table, 1959, pub. 1960.

Mention is made of the occurrence of algarites or "paraffin dirt" in various places of the Kala region on the Apsheron peninsula. The material is a secondary development formed at the surface within a relatively short time by bacteria oxidizing combustible gas.--C. Voûte.

3-980. International Oil Scouts Association and Society of Petroleum Engineers, AIME. INTERNATIONAL OIL AND GAS DEVELOPMENT. REVIEW OF 1959. PART I.: Internatl. Oil Scouts Assoc., v. 30; Soc. Petroleum Engineers, AIME, v. 14, 832 p., maps, secs., charts, tables, Austin, Texas, 1960.

This publication is the consolidation of the annual oil and gas statistical volumes of these 2 organizations. The International Oil Scouts Association (formerly National Oil Scouts & Landmen's Association) review of 1958 was listed as GeoScience Abstracts 2-235. The combined efforts of the 2 organizations will result in a 2-part annual volume. Pt. 1 is an annual review of geological and geophysical prospecting, land and leasing activities, wildcat exploration, and proven field development in both domestic and foreign areas. Each area is subdivided into classes of information such as charts, discoveries, exploratory well record, geophysical prospecting, etc. In the United States, field discoveries, new pays, and extensions are listed alphabetically by field under each county. At the beginning of each geographical division of an area is a map showing which counties or areas are covered by that report.

Pt. 2 of this annual volume reviews refining, pipelines, and production in both domestic and foreign areas. All established oil or gas fields are listed in Pt. 2, and cumulative and current production are shown, but discoveries, new pays, and extensions are shown only in Pt. 1.--From foreword, Pt. 1.

3-981. MINING AND ORE DISPOSAL COMPLICATE TAR SANDS DEVELOPMENT: Petroleum Week, v. 11, no. 5, p. 20-21, 3 illus., Aug. 5, 1960.

The materials-handling aspects of mining and the disposal of tailings may prove tough barriers to economic development of Alberta's Athabasca tar sands (see also GeoScience Abstracts 2-754).

The principal problems are: 1) disposal of the enormous volume of oily, flow-prone sand that amounts to about 1 cu. yd. per barrel of oil extracted; 2) soft pockets in the sands and general deterioration of strength of the sands during above-freezing weather prevent the experimental bucket-wheel excavator used to mine the oil sands from operation satisfactorily from a bench (working roadway); and 3) much more limestone and shale are in the oil sands than coring had indicated. Further study is necessary to solve these problems economically.--C.C. McFall.

3-982. Dawson, T.A., and others. CATALOGUE OF WELL SAMPLES OF THE INDIANA GEOLOGICAL SURVEY: Indiana, Geol. Survey, Directory 8, 458 p., 4 figs., 4 tables, 1960.

A compilation of well cuttings and crushed cores from 5,476 Indiana wells and 360 out-of-state wells on file in the Petroleum Section of the Indiana Geological Survey on July 1,1958. In addition, insoluble residues reduced from sample sets to facilitate special stratigraphic studies are listed. The publication includes maps showing distribution of the sample sets and an illustration of a typical lithologic strip log (log made by gluing samples on strips). Lithologic strips, which permit rapid viewing of well cuttings, are available for many of the sample sets and are so indicated in the tables. The sample sets, classified and filed, constitute a sample library which is maintained to accommodate industry and research personnel. Facilities are available for studying samples at the Indiana Geological Survey. Use of these facilities is welcomed.--Auth.

3-983. Smith, Gene. SOVIET ENERGY SOURCES TERMED TWICE THOSE OF THE FREE WORLD: New York Times, v. 110, no. 37,619, Sec. 3, p. 1-F, cols. 4-5, p. 10-F, cols. 4-7, Jan. 22, 1961.

The Sino-Soviet bloc presently consumes coal, oil, and gas at the rate of only 1,350 million short tons of coal - equivalent to the Free World's 3,220 million short tons, and by the year 2,000 the ratio will still probably be in the Free World's favor by 11,368 to 5,486. However, if all conventional resources for energy are considered, the Soviet Union alone has nearly twice the potential of the Free World - 8,993 billion short tons to 4,939 billion short tons. The Soviet Union's energy reserves, exclusive of hydroelectric, are 7 trillion tons of standard fuel.--M. Russell.

3-984. Ilin, A.A., and P.I. Levitsky. RESULTS OF GEOLOGIC EXPLORATION FOR OIL AND GAS FOR 1958: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 71-74, 104, 1959, pub. 1960.

The yield of oil in the U.S.S.R. reached 113 million tons in 1958, an increase since 1957 of 15 million tons. Gas production in 1958 was 30 billion m.^{3}, an increase since 1957 of 10 billion m.^{3}. Oil and especially gas reserves also increased considerably in 1958. New fields were found in the Volga-Ural provinces, the Cis-Caucasus, Dnepr-Donets depression, Cis-Carpathian downwarp, Azerbaijan, Turkmen, Uzbekistan, W. Siberia, and on Sakhalin. In E. Siberia positive signs of oil and gas were found in the Cambrian, but not yet in commercial quantities.--C. Voûte.

3-985. THE MAIN TASKS OF GEOLOGICAL EXPLORATION FOR OIL AND GAS IN 1959-1965: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-A, p. 1-8, 1959, pub. 1960.

Goals have been set for a further large increase of U.S.S.R. oil and gas production, which should provide 51% of the total fuel production in 1965 as compared with 31% in 1959. Plans call for an oil production of 230-240 million tons and a gas production of 150 billion $m.^3$ in 1965. Geological exploration in the present commercial oil and gas provinces and in the new highly favorable areas of Middle Asia has to be increased correspondingly in order to secure the necessary oil and gas reserves for this production and for the planned growth of the next 15 years. The paper further lists separately the various regions and districts where production has to be intensified or exploration has to be increased or where important reserves have already been found.--C. Voûte.

3-986. Brod, I.O. THE CIS-CAUCASUS - A VERY LARGE BASE FOR INCREASING THE OIL PRODUCTION AND FOR GASIFICATION OF THE EUROPEAN PART OF THE U.S.S.R.: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 75-78, 1959, pub. 1960.

A brief summary is given of the oil and gas prospects of the Mesozoic-Tertiary sequence, mainly in the Krasnodar and Stavropol regions. Indications are given on the most favorable structures to be explored.--C. Voûte.

3-987. Kozhevnikov, I.I. THE TECTONICS AND OIL AND GAS POSSIBILITIES OF THE NORTHERN PART OF THE TERRITORY OF NORTH CASPIAN DEPRESSION: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-A, p. 18-26, map, profile, 2 secs., 1959, pub. 1960, 5 refs.

Discusses the main geological features of an area connecting the Volga-Ural petroleum-gas-bearing regions and the Caspian salt dome area. Data are provided on the variations in thickness and lithology of the stratigraphic sequence from Middle Devonian up to Paleocene. The main structural elements are described. The Tokarev regional dislocation can be regarded as the southern boundary of the Volga-Ural oil-bearing region. Salt domes are everywhere situated to the S. of it. They are clearly oriented in accordance with the general tectonic outlines of the Pri-Caspian area. A zone of highly productive oil and gas deposits, almost 1,000 km. long, lies along the western and northern margins of the N. Caspian depression.--C. Voûte.

3-988. Shpilman, I.A. SOME PROSPECTING FEATURES OF BURIED STRUCTURES: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-B, p. 35-39, 4 maps, 2 diags., 1959, pub. 1960.

In Bashkir and Tataria, U.S.S.R., drilling disclosed many places where the Permian and Carboniferous are warped into clear folds but where the underlying Devonian shows only very gentle monoclinal dips. It is believed that structures which are not reflected in the covering formations are more frequent than has been assumed so far, representing potential traps of oil and gas. Drilling revealed a new large-scale oil deposit in a region (near Novo Elkhovo) where the monocline of the Devonian showed an uneven change of dip, thus indicating buried structures. The origin of the buried structures is attributed to ancient buckling followed by general regional movements leading to a monoclinal dip. The overlying sediments varying in thickness conceal these structures.--C. Voûte.

3-989. Kulikov, F.S. ARLANO-DYURTYULIN OIL-BEARING ZONE: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 84-91, map, 2 secs., 1959, pub. 1960.

The region described corresponds to a structural saddle situated between the Tatar dome and the Bashkir dome. The productive deposits belong to the lower Carboniferous. The main tectonic deformation took place during the Tournaisian, followed by erosion and abrasion creating deep canyonlike channels. The overlying lower and middle Carboniferous and Lower Permian mostly show the same structural pattern, but in a subdued form. However the structures observed in the Carboniferous do not correspond to similar structures in the underlying Devonian sequence.--C. Voûte.

3-990. Dubinin, A.Z., and P.V. Ivanov. SOME DATA ON THE DEVELOPMENT OF THE LOWER CARBONIFEROUS OIL POOL OF THE MUKHANOV FIELD: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 2-A, p. 97-104, 3 maps, diag., graph, table, 1959, pub. 1960.

Information is given on the characteristics and exploitation methods of 4 commercially oil-bearing horizons of the lower Carboniferous, consisting of highly permeable thick strata of sandstones separated by thin layers of shale and clay. Only 2 of the 4 layers were saturated with oil. Stratum 1 was developed by an independant network of wells without injection of water, strata 2, 3, and 4 jointly by means of another network, formation pressure being maintained by injecting water into the various levels.--C. Voûte.

3-991. Zubov, I.P. THE TASKS OF OIL AND GAS EXPLORATION IN MIDDLE ASIA: Geologiya Nefti - Petroleum Geology [in translation], v. 3, no. 1-A, p. 14-17, 1959, pub. 1960.

The present status of prospection and exploitation and the enormous possibilities of the Uzbekistan-Turkmenia-Tadzhikistan-Kirgizia area are considered. According to the plans the relative importance of oil and gas production in Central Asia in comparison with the all-Union output will increase from 4.4% in 1958 to 8.5% in 1965, the rise of gas production only during that period being from 1.3% of the total for the U.S.S.R. to 14.3%.--C. Voûte.

3-992. Yudin, G. T., and Ya. P. Malovitsky. OIL FIELDS OF THE EGYPTIAN REGION OF THE U.A.R.: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-B, p. 1054-1061, map, profile, 2 secs., 2 tables, 1958, pub. 1960, 10 refs.

A description of the stratigraphy and lithology of the Paleozoic, Mesozoic, and Cenozoic in Egypt. Moreover mention is made of the 3 main systems of dislocations: Acaba graben, Suez graben, and the longitudinal zones of uplift which extend from the northern Sinai peninsula westward. Local structures are situated on these tectonic lines. All of the oil fields thus far discovered are situated in the Suez area. Their structural position is indicated. Exploration work recently done in the western desert and in the northern Sinai peninsula is mentioned.--C. Voûte.

3-993. Hutchison, Harold C. GEOLOGY AND COAL DEPOSITS OF THE BRAZIL QUADRANGLES, INDIANA: Indiana, Geol. Survey, Bull. 16, 50 p., 3 figs., 2 pls., 2 tables, 1960.

The Brazil quadrangles are located in W.-central Indiana and comprise an area of approximately 116 sq. mi. The rocks that crop out in the area belong to the Mansfield, Brazil, Staunton, and Linton formations of the Pennsylvanian system. Glacial drift of Kansan, Illinoian, and Wisconsin age blankets the area, and Recent deposits of sand, silt, and mud cover the flood plains of the present streams.

Five unnamed thin coals and 4 unnamed marine zones in the Staunton formation are described for the first time. The Perth limestone member in the upper part of the Brazil formation and the Shady Lane coal, a coal bed that occurs some 30 to 40 ft. below the top of the Mansfield formation, are herein described and formally named.

Coal reserves of the major commercially mined coals, the Lower Block, Upper Block, and Minshall of the Brazil formation and Coal III of the Staunton formation, are calculated according to the standard methods employed by the U.S. Geological Survey. Of the original 476,786,000 short tons of coal present in the area, 401,403,000 short tons remain.--Auth.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 3-736; Areal and Regional Geology 3-752; Geohydrology 3-919.

3-994. California Association of Engineering Geologists. PROGRAM, 1960. 3D ANNUAL MEETING, OCTOBER 14 AND 15, FIELD TRIPS, OCTOBER 16: 15 p., P.O. Box 4164, Sacramento 21, California, 1960.

This meeting, held at the University of California, Berkeley, included a technical session, a symposium on engineering geology of the Franciscan formation, and field trips to examine the Lafayette Tunnel No. 2, the San Francisco Bay Model, and the type section of the Franciscan formation. The program includes abstracts of a banquet address and of papers given at the technical session (p. 5-15). These are listed below:

Banks, Harvey O. The Relationship of Geologists and Engineers in Planning Public Works Projects.
Ellis, William C. The Problem of Perched Ground Water in Northeastern Sacramento County, California.
Fisher, Paul R. Slush Grouting of Rock Foundations for Earthfill Dams.
Fuqua, W.D., W.W. Peak, and C.V. Lucas. Land Subsidence in the San Joaquin Valley, California, Resulting from Water Application.
Hanson, Hal C. and Ronald P. Bisio. Evaluation of Water Pressure Testing Equipment.
Kiersch, George A. Regional-Areal Investigations in Engineering Geology.
Lofgren, Ben E. Land Subsidence in the Tulare-Wasco Area, California.
Mitchell, Stanley N. Establishing the Use of Engineering Geology in the Colorado Department of Highways.
Nelson, Jerome S. Serpentine Delineation in North Coastal and Other Areas by Mapping Associated Magnetic Anomalies.
Spencer, Ned D. Terminus Dam Foundation.
Thomas, Robert G. Geohydrology of the Coastal Plain of Los Angeles County with Application to an Analog Computer.
Thompson, Thomas F. The Contractor's Hill Slide, Its Causes and Correction.

Papers presented at the symposium, summaries of which appear in the program, were as follows:

Bailey, Edgar H. The Franciscan Formation, its Distribution and Peculiarities.
Gardner, William I. Tunnels in the Franciscan Formation.
Goldman, Harold B. Franciscan Formation As a Source of Construction Materials. Part II - Crushed Stone, Sand and Gravel, Dimension Stone.
James, L.B. and W.A. Brown. California's Franciscan Formation as a Foundation For Dams and Appurtenant Structures.
Schlocker, J. Geologic Features of the Franciscan Formation of Significance In Engineering.
Smith, Travis W. Landslides in the Franciscan Formation.
Treasher, Ray C. Franciscan Formation as a Source of Construction Materials. Part I - Broken Stone.

--E.B. Eckel.

3-995. Odell, R.T., and others. RELATIONSHIPS OF ATTERBERG LIMITS TO SOME OTHER PROPERTIES OF ILLINOIS SOILS: Soil Sci. Soc. America, Proc., v. 24, no. 4, p. 297-300, 2 illus., 4 tables, July-Aug. 1960, 9 refs.

Multiple correlations were determined between liquid limit, plastic limit, and plasticity index and various combinations of standard physical and chemical determinations (cation-exchange capacity, percent of organic C, percent of <0.002-mm. clay, percent of montmorillonite in the clay separate, percent of illite in the clay separate, and percent of 0.05- to 0.002-mm. silt) on a wide range of Illinois soils.

Multiple correlation coefficients of 0.959, 0.887, and 0.938 were obtained between liquid limit, plastic limit, and plasticity index, respectively, and 3 soil properties (percent of organic C, percent of clay, and percent of montmorillonite in the clay separate), indicating that there is a very close relationship between Atterberg limits and these 3 soil properties. If additional soil properties, such as percent of silt and percent of illite in the clay separate, are included in the analysis, the correlation coefficients are increased only slightly. Lower, but highly significant, correlations were also obtained between each of the Atterberg limits and cation-exchange capacity, and a combination of percent of organic C and percent of clay.--Auth.

3-996. STRUCTURES DON'T SETTLE IN THIS SHALE; BUT WATCH OUT FOR HEAVE: Eng. News-Rec., v. 164, no. 5, p. 46-48, 4 illus., Feb. 4, 1960.

In sections of the Midwest, particularly eastward from Cleveland along the shore of Lake Erie, failures in walls, floors, stairways, and sewer lines have been caused by heaving of a pyritiferous shale foundation. In Ohio the shale contains up to 4.5% pyrite. The pyrite grains range from microscopic to 1/4 in. in diameter. Pyrite expands up to 10 times its normal size when exposed to dampness. An analysis of the shale in 1935 revealed that pyrite was the only unoxidized compound present, and thus oxidation and the subsequent expansion of pyrite was suspected as the cause of heaving.

Heaving is also caused by the increase in volume due to the splitting of the shale. Cracks up to 2 mm. wide developed parallel and perpendicular to the plane of fissility in a sample of the shale within 24 hours after being exposed to warm, moist air. Pyrite was found in the cracks. As cracks develop, air permeates deeper into the shale and causes more swelling. Although a laboratory test showed that the shale could lift 2 p.s.i., it is believed that the actual lifting power of the shale is much greater. A very effective remedy against heaving has been to excavate the shale to within a few inches of grade and then to seal the shale with bitumen or to leave it exposed until the site is prepared for pouring concrete. The shale is then cut to final grade and immediately sealed with concrete, bitumen, clay, or bitumen overlain by clay.--R.E. Pendergast.

3-997. Hiltrop, Carl L., and John Lemish. RELATIONSHIP OF PORE-SIZE DISTRIBUTION AND OTHER ROCK PROPERTIES TO SERVICEABILITY OF SOME CARBONATE AGGREGATES (In: Physical and Chemical Properties of Cement and Aggregate in Concrete: Natl. Research Council, Highway Research Board, Bull. 239, p. 1-23, 10 figs. incl. illus., map, graphs, 8 tables, 1960) 22 refs.

The pore-size distribution present in some carbonate rocks was determined as part of an investigation concerned with the properties of aggregate which affect the durability of portland cement concrete. Pore-size distribution is considered critical in controlling flow and retention of water in aggregate. Those properties, in turn, might be related to an aggregate's effect on the resistance of concrete to freezing and thawing and to potential chemical reactivity of the aggregate in concrete.

Pore-size distributions were determined by use of a Hg capillary pressure apparatus manufactured by Ruska Instrument Corp., Houston, Texas. Several other properties of the rocks were also determined. Those properties are: a) effective porosity, b) total porosity, c) Ca-Mg ratio, d) insoluble residue, 3) amount of clay present, f) loss in weight in freezing-and-thawing, g) service record, and h) texture.

Statistical questions were then asked about the relationships between the various properties and answered tentatively on the basis of the frequency of occurrence of the properties in these data. This investigation shows: 1) A large number of the rocks sampled possess pore entry distributions with maxima in the region of radius less than, or equal to, 0.5 micron. 2) Knowledge of a rock's pore-size distribution might be of value in attempting to predict its service record as aggregate. 3) The "frequency-of-occurrence" method lends itself well to the characterization of a rock. One may ultimately be able to thus describe a typical "poor" aggregate. --J. Lemish.

3-998. Flanagas, William G., and Lysle E. Shaffer. AN APPLICATION OF NUCLEAR EXPLOSIVES TO BLOCK CAVING MINING: California, Univ., Radiation Lab., [Pub.] UCRL-5949, 23 p., June 2, 1960.

Drilling and mining explorations at the site of the Rainier event (detonated at the Nevada Test Site of the U. S. Atomic Energy Commission) have revealed that it is possible to mine back into the area of a nuclear explosion by the use of commonly accepted mining methods. Therefore, it also appears possible to apply nuclear explosives in preparation for mining by a modified block-caving technique.--Auth. (courtesy Nuclear Science Abstracts, v. 14, no. 19, p. 2468-2469, abs. 19201. Publication not seen at AGI).

3-999. ROAD EMBANKMENT CONSTRUCTION WITH ROCK AND MIXED MATERIALS: World Construction, v. 13, no. 10, p. 13-17, 6 illus., Oct. 1960.

Rock cuts up to 90 ft. deep along 4.5 mi. of Route 8 in Connecticut were chiefly in mica schist and pegmatite that contained many granitized zones, slightly weathered joints, and soft areas. Locally the rock was very hard, fine-grained, granitized schist. All rock units made good fill when properly used, although the mica flakes caused the top 12 in. to become a slippery paste during wet weather. The rock caused heavy wear on the equipment. Many large blocks of rock slid into the cuts along unpredicted slick joint and foliation planes. These were controlled by cutting back the slopes until stability was attained.--R. Van Horn.

3-1000. MacDonald, D.H., and others. KELSEY GENERATING STATION, DAM AND DYKES: Engineering Jour., v. 43, no. 10, p. 87-98, 8 illus., 7 tables, Oct. 1960, 10 refs.

First hydroelectric plant on the Nelson River (flowing into Hudson Bay in northern Manitoba) has been constructed by the Manitoba Hydro-Electric Board at the historic Kelsey Rapids, 425 mi. N. of Winnipeg. The initial installation of 210,000 h.p. (half the ultimate), generated under a head of 55 ft., is for supplying the new Ni mining development at Thompson, 60 mi. to the S. A rock-fill sloping core dam 120 ft. high and 955 ft. long across the old river bed diverts water to a conventional type of low-head power house. Clay dikes 6,250 ft. long and with a maximum height of 38 ft. were necessary in the reservoir area, together with 3,900 ft. of sand dikes up to 20 ft. high. The latter are built over perennially frozen varved clays and glacial till ("permafrost") containing ice lenses up to 7 in. thick. These dikes are believed to be unique in this respect. They have been fully instrumented, together with the adjacent natural ground, by the Division of Building Research of the National Research Council of Canada in order that the effect of the filling of the reservoir upon the permafrost condition may be observed and recorded.--R. F. Legget.

3-1001. Carey, L.A. WHITEHORSE RAPIDS POWER DEVELOPMENT: Engineering Jour., v. 43, no. 10, p. 81-86, 5 illus., Oct. 1960.

One mile upstream from the city of Whitehorse, Yukon Territory, where an ancient lava flow created the Whitehorse Rapids (famous in Klondike days), the

Lewes River has been dammed in order to create the necessary head for a power station equipped initially with two 7,500 h. p. units, with space for a future third unit, operating head being 61 ft. Some trouble was experienced in preparing foundation beds in the lava flows, which varied from volcanic ash to dense basalt, due to hydration of some strata. Loading on the rock was limited to 10 tons per sq. ft. The main dam, diverting the river flow into a half-mile headrace canal, and the embankments forming the canal, are conventional earth dams with impervious silt cores, pervious gravel flanks, and integral sand filters. The spillway dam is of concrete. Steel sheet piling driven to underlying glacial till provided an impervious cut-off. A timber fish ladder 1,200 ft. long, provides for the passage of salmon past the main dam.--R. F. Legget.

3-1002. Winslow, John D., and others. ENGINEERING GEOLOGY OF DAM SITE AND SPILLWAY AREAS FOR THE MONROE RESERVOIR, SOUTHERN INDIANA: Indiana, Geol. Survey, Rept. Prog. 19, 19 p., 2 figs., pl., 3 tables, 1960.

The Salt Creek drainage basin in Monroe, Brown, and Jackson counties, Indiana, was studied to provide basic information for the planning of the Monroe Reservoir. This report principally concerns the dam site and spillway areas of the proposed reservoir.

Four units, defined on the basis of engineering characteristics, are present in the reservoir area. Impermeable siltstones of the Borden group [Mississippian], form the valley walls along Salt Creek and will confine the reservoir. Rocks of a second unit, the Harrodsburg and Salem limestones [Mississippian], cap the ridges high above flood-pool level (556 ft.). The 2 remaining units consist of unconsolidated materials in the valley of Salt Creek. Terrace deposits above the flood plain are sandy to gravelly silts. Valley-fill deposits as much as 70 ft. thick are present in the valley of Salt Creek. Clayey silts predominate in the valley fill and form a satisfactory foundation material of low permeability for the dam.

Two spillway locations have been considered for the Monroe Reservoir. The first, a short distance from the dam site, would require a channel through about 90 ft. of bedrock, the upper 50 ft. of which would be the Harrodsburg limestone. This site would be near the dam, and rock excavated from the spillway channel could be used as fill material in the dam. A second potential spillway site lies about 1 mi. S. of the dam. Here the spillway channel would cut through 40 ft. of material, 20 to 30 ft. of which are unconsolidated sediments; the remainder is siltstone belonging to the Borden group.--Auth.

3-1003. Anderson, H. Kenneth. SIX BILLION GALLONS FOR $2,834,548: Water Works Eng., v. 113, no. 4, p. 284-287, 8 illus., Apr. 1960.

The cost of the Portland, Oregon, Bull Run No. 2 water supply dam was minimized by spillway model studies which allowed a reduction of excavation and by geologic studies necessary for material planning and tunnel construction.

Bull Run River is entrenched into young glacial moraines and irregular intermittent Tertiary lavas and agglomerates. The area is further complexed by later mud and debris flows. Tunneling operations were impeded by various sized boulders without interstitial filling. The shifting boulders burst liner plates, but were finally mastered by grouting from the surface. Materials excavated from the spillway section are to be used in the dam. Impervious fill is residual clay with gravel and cobbles, and random fill consists of sand, gravel, and boulders with some clay and material from the mud and debris flows. These materials require drying for proper compaction. Material for drainage layers is obtained from sand and gravel from bars and terraces. Porous zones in the reservoir area are to be sealed with a blanket of clay with grouting where necessary. The spillway approach and the foundation of the structures consist of fused debris flow which has sufficient strength but must be protected from erosion due to erratic consolidation. Loose pervious block debris that exists in the old river channel will be grouted extensively. Propitiously, it was feasible to locate the spillway stilling pool in basalt.--J.E. Garrison.

3-1004. Strauss, Michael. DRILLING THE ALPS: New York Times, v. 110, no. 37,612, sec. 2, pt. 2, p. 23, cols. 1-3, illus., Jan. 15, 1961.

Rock falls, flooding, and ineffective ventilation have caused delays in the construction of the Mont Blanc vehicular tunnel being driven between Courmayeur, Italy, and Chamonix, France. The estimated date of completion has been extended from late 1961 to late 1962 because of the extensive need for concrete lining of zones of easily crumbled rock and diverting of ground-water flows of as much as 66 gallons per sec.--M. Russell.

3-1005. Becker, G. W., and others. NATURAL WATERWAYS: PREVENTION OF EROSION: Am. Railway Eng. Assoc., Bull., v. 61, no. 556, p. 658-663, 4 illus., Feb. 1960.

The current report presents data illustrating the degradation effect occurring downstream from 3 different unnamed reservoirs and discusses the probable effects of such action on existing or proposed bank protection below a reservoir.

Drainage areas above the 3 reservoirs vary from 12,000 to 180,000 sq. mi. and are located on streams normally carrying a heavy silt load during periods of high discharge. Conclusions: 1) where reservoirs are constructed on alluvial streams, bank cutting and channel widening can be expected downstream; 2) flow below the dam will tend to establish a condition of equilibrium by flattening slopes and widening channels; 3) permeable bank protection will tend to produce reduced or insignificant quantities of depositional material; 4) riprap bank lining may undercut and slump in desilted streams; 5) regulated outflow from a storage reservoir with attending fluctuation of stages downstream may result in heavy saturation of banks, followed by tendency to slough and cave.--C. S. Gwynne.

3-1006. National Academy of Sciences-National Research Council. THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION. SUMMARY REPORTS FROM A STUDY BY THE NATIONAL ACADEMY OF SCIENCES: 90 p., graph, 2 tables, 1960, 30 refs.

In June 1956 the National Academy of Sciences published the first summary reports of the findings and recommendations of 6 committees established to study the biological effects of atomic radiations. These committees cover the fields of genetics, pathology, meteorology, oceanography and fisheries, agriculture and food supplies, and the disposal and dispersal of radioactive wastes. The present volume contains new summary reports, bringing the findings of the committees up to date, to 1960. The summary reports will be followed by reports in detail on a number of special problems.--From foreword.

The report of the Committee on Disposal and Dispersal of Radioactive Wastes (p. 57-66) deals with the following topics: present status of radioactive waste disposal; problem areas now under investigation; cost of radioactive waste management; magnitude of future management problem; federal-state relationships; international aspects; effects of waste management operations on man's over-all radiation exposure.

3-1007. National Academy of Sciences-National Research Council. A REPORT TO THE PUBLIC ON THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION. BASED ON THE 1960 SUMMARY REPORTS OF THE NATIONAL ACADEMY OF SCIENCES, COMMITTEE ON THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION: 19 p., 1960.

Contains abstracts of the summary reports of 6 committees (see abstract above), including (p.9-10) report of the Committee on Disposal and Dispersal of Radioactive Wastes.

3-1008. Haney, W.A., and J.F. Honstead. A HISTORY AND DISCUSSION OF SPECIFIC RETENTION DISPOSAL OF RADIOACTIVE LIQUID WASTES IN THE 200 AREAS: General Electric Co., Hanford Atomic Products Operation, Richland, Washington, [Pub.] HW-54599, 12 p., Apr. 1958, declassified Apr. 1960.

Specific retention is defined at Hanford as that volume of water that may be disposed to the soil and be held against the force of gravity by the surface tension characteristics of the soil surfaces and pores, when expressed as percent of packed soil volume. A history of this method of disposal at Hanford from 1944 through 1957 is presented, and recommendations for its use are outlined. A value of 6% by volume is recommended for specific retention application until unknowns associated with this disposal method can be more completely evaluated. About 6% by volume is thought to be a conservative value that recognizes the uncertainties resulting from poorly defined physical characteristics and lack of more certain information regarding the mechanism. In addition, continued discrimination against disposing of wastes by this method, even under the more restrictive conditions, is recommended.--C.H. (courtesy Nuclear Science Abstracts, v. 17, no. 7, p. 2254, abs. 17634. Publication not seen at AGI.)

3-1009. Peck, Ralph B., and Don U. Deere. INVESTIGATION OF LANDSLIDES FOR PLANNING REMEDIAL MEASURES: Am. Railway Eng. Assoc., Bull., v. 61, no. 556, p. 670-677, 6 illus., Feb. 1960.

First step is the collection and organization of all the available history of movement in the area. A program of test borings is then set up; the type, number, depth, etc., is dependent on local conditions. Each boring should, if practicable, be converted into a standpipe for observation of ground-water levels. The shape and dimensions of the sliding mass are determined; a topographic map is prepared using ground surveys and airphotos. The position of the surface of sliding must be established as accurately as possible. The use of a tiltmeter is recommended for establishing the zone of movement. This also aids in establishing the rate of movement. Examples of investigations are given.

No slide analysis or recommendations can be made unless pertinent factors concerning the slide are known, including topography and shape of the sliding mass, ground-water conditions, the strength and arrangement of the various strata, and the effect of varying piezometric levels on the rate of movement of the slide.--C.S. Gwynne.

3-1010. U.S. Geological Survey. MILITARY GEOLOGY OF GUAM, MARIANA ISLANDS. PART I. DESCRIPTION OF TERRAIN AND ENVIRONMENT. PART II. ENGINEERING ASPECTS OF GEOLOGY AND SOILS. By Joshua I. Tracey, Jr., and others. Prepared under the direction of the Chief of Engineers, U.S. Army, by the Intelligence Division, Office of the Engineer, Headquarters U.S. Army Pacific, with personnel of the U.S. Geological Survey: 282 p., 19 figs. incl. maps, secs., graphs, 49 pls. (incl. 5 maps in pocket), 21 tables (6 in pocket), [Washington, D.C.], 1959, 79 refs.

Pt. 1 includes basic data on geology, geography, soils, vegetation, and climate. In Pt. 2, laboratory tests of rock and soil, and specific observations in the field, furnish additional basic information, from which are evaluated the suitabilities for construction materials, road and airfield construction, and underground installations. Pt. 3 (not abstracted here) is a separate classified volume evaluating suitabilities of the terrain for amphibious and airborne operations and for cross-country movement. Water resources will be published as a supplement.--From foreword.

Guam, 225 sq.mi. in area, is one of the larger, more complex islands of the Pacific. It is composed of volcanic flows and tuffs partly covered by coralline limestones and is geomorphologically complex. Three physiographic provinces are recognized, the northern plateau, the central mountains, and the southern mountains. The northern plateau is the product of uplift, tilting and faulting, and weathering of limestones. It is separated from the central mountains by fault-line scarps. The central mountains display a dissected terrain whose complexity is emphasized by many ridges and knobs. The southern mountains province is dominated by a high cuesta parallel to the W. coast and by a gentle, dissected, dip slope overlapped on the E. by limestones. These southern mountains, separated from the central mountains by a relatively old structural valley, were tilted eastward, with normal faulting along the W. coast and hinge faulting along the structural valley.

Guam is made up of Eocene limestones and volcanics, Oligocene shales, Miocene volcanics, and Miocene to Recent limestones. The island's central core is a succession of more than 2,000 ft. of folded and faulted marine tuffs, limestones, conglomerates, and lava flows of Eocene and Oligocene age - the Alutom formation - which includes at least 200 ft. of shales rich in Oligocene Foraminifera - the Mahlac member. The northern plateau is a limestone cap resting unconformably on the Alutom formation and comprising the relatively flat-lying Bonya limestone, Janum formation, and Barrigada limestone, all Miocene, and the Pliocene-Pleistocene Mariana limestone. The southern mountains are composed of a succession of Miocene volcanics and limestones 2,200 ft. thick, dipping gently E. This succession, the Umatac formation, comprises 4 members: the Facpi basalt member, the Bolanos conglomerate member, the Maemong limestone member, and the Dandan basalt member. The Umatac formation is thought to be in fault and overlap contact with the Alutom formation. Several distinct periods of structural deformation affected the formations described above. Fringing reefs border Guam except where the coastline is limestone cliffs. In 2 places barrier reefs partly enclose small lagoons. The fringing reefs range from narrow, cut algal-veneered benches around limestone headlands to broad coral and algal reef flats more than 3,000 ft. wide. Peripheral submarine terraces are tentatively recognized at depths of 55 ft., 105 ft., 195 ft., 315 ft., and possibly 1,200 ft.

Guam is within the belt of tropical soils, and although the soil-forming processes are predominantly lateritic, the island has no significant areas of true laterite soil. Regosols, lithosols, latosols, and lithosolic latosols are the great soil groups most extensively represented. In the northern half is an extensive lithosolic latosol rich in hydrated oxides of Fe and Al. In southern Guam, regosols and latosols are predominant on the volcanic rocks. Minor areas of lithosols and latosols are on the hills and scarps of fringing limestone terrace remnants along the coast and on limestone outliers in the volcanics. In central Guam is a large area of moderately deep clays on argillaceous limestones. Other soils include a regosol and alluvial soils. Stream drainage patterns are developed in the southern province of volcanic soils and in the central area of limestone karst, but no continuous surface drainage ways are developed in the more porous limestones of the northern plateau.

The greater part of Guam is forested, but substantial areas are covered by coarse grass, and smaller parts are in pasture or under various kinds of cultivation. There are few large stretches of uniform vegetation; most of the island is covered by a mosaic of small patches of extremely varied appearance. Limestone areas commonly are wooded except for some vertical cliffs and clearings. The southern volcanic half of the island is a complex mosaic of grassland and patches of forest.

Geologic construction materials are abundant. Hard limestone for crushed coarse aggregate, for concrete and surface course, base course, and riprap is available and accessible, except on much of the southern half of the island. Coralline rubble suitable for base course is abundant. Fine sand fairly suitable for concrete is locally available, and clay for binder is commonly available. Volcanic rock similar to trap rock is common, but this material is suitable for concrete aggregate from only a few relatively inaccessible dikes. Excavation in well lithified limestone in northern Guam requires drilling and blasting; poorly lithified limestone at some places can be excavated with power tools. Excavation of fresh volcanic rock in southern Guam requires drilling and blasting; the weathered rock can be excavated with hand or power tools. Wet clay overburden sticks to excavation equipment. Foundation conditions are good on most of the limestones, but the possible presence of caverns should be investigated. Foundation conditions are generally good on the sound volcanic rock of the southern part of the island but are poor on deeply weathered slopes and in swamps, marshes, and deep alluvium of valleys. Road construction is easy over much of the limestone plateau of N. Guam, moderately difficult over hilly limestone terrain and low rolling hills of volcanic rock, and difficult across limestone scarps and steep hills of volcanic rock. Drainage and slope protection is necessary in all areas of volcanic rock, and special problems arise in marshy areas everywhere. Suitable localities for underground excavations are available at the foot of precipitious slopes in both limestone and volcanic rock. Most suitable locations for airfields are already occupied. In all areas, construction planning must consider the possibility of typhoons.

Six major engineering soil groups occur: 1) thin clayey silt (Unified Soil Classification rating ML); 2) fat clay to silty clay (CH - MH), commonly 1 to 10 ft. thick; 3) soil containing silty clay (MH) in its upper part and sandy silt (SM) in its lower part, ranging in thickness from a thin veneer to 100 ft.; 4) poorly drained or frequently flooded silty clay (MH), 3 to 150 ft. thick; 5) continuously saturated silty muck and peat soil (Pt), 3 to 20 ft. thick; and 6) poorly graded sand (SP) with little or no fines, generally 3 to 35 ft. thick. Drainage and erosion characteristics vary widely. For any form of excavation or engineering construction, cognizance must be taken of their thickness, strength, and stability; otherwise there is significant risk of engineering failure.--M. Russell.

15. MISCELLANEOUS

3-1011. Carrington, Richard. A BIOGRAPHY OF THE SEA: 286 p., illus., maps, chart, profile, diags., New York, Basic Books, 1960, approx. 250 refs.

A summary of the history of the sea and the evolution of marine life through geological time, with general information concerning the sea as a physical feature of the earth, and the way it has influenced the lives of men.

Pt. 1, World Ocean, deals with earth and sea, origin of the ocean basins, changing patterns of sea and land, sea water, the sea in motion, and sea and climate. Pt. 2, Life of the Sea, covers the sea as a home for living things, sea organisms, ocean wanderers, life on the sea floor, free-swimmers, sea reptiles, birds, and mammals. Pt. 3, Man and the Sea, contains the following chapters: discovery of the oceans, growth of sea science, harvest of the sea, the sea and the spirit of man.

3-1012. Firsoff, Valdemar A. STRANGE WORLD OF THE MOON: 226 p., illus., New York, Basic Books, [1960, c1959], refs.

The main subject of the book is the present condition of the moon, with special reference to the atmosphere, surface and subsurface structure, as well as the possibility of life. The problems of selenology, with special reference to the origin of surface features are likewise considered.

The book is intended to be accessible to a layman without specialized knowledge and for this reason contains a good deal of background information, but it is not elementary in scope or treatment, and a technical and mathematical appendix is provided.

The differential contraction of the lunar surface established by J.E. Spurr and indicating a rapid reduction in the speed of rotation is taken to indicate that the moon may have had independent planetary origin before its gravitational capture by the earth.

Recessions and "recaptures" may have occurred and may be correlated with lunar and perhaps terrestrial orogenies. The position of the rotational axis of the moon appears to have changed, which is indicated by 3 clear systems of lines of tectonic weakness (fractures, crater chains, faults and overthrusts), which the author considers of great importance for understanding the origin of lunar features. Meteoritic theory is rejected in favor of a modified plutonic hypothesis. Owing to lack of subaerial denudation and low surface gravity, the surface may consist largely of porous soluble formations lighter than water, which would accumulate underground. These underground waters, relatively hot and carrying rock-matter in solution, would have played in selenology the part of our magma.

Lunar atmosphere is considered to consist of a very thin outer halo of conventional structure and a thin gas skin evolving in the heat of sun rays from the gases sorbed by the surface and resorbed by it during the night. Numerical investigation indicates that snow could exist on the lunar surface, provided it were replenished from time to time from the subsurface hydrosphere. Some salts, especially halides, will volatilize appreciably in daytime, adding to the density of the ground air skin.

The porous and dusty ground will act as a king of "gas marsh" which might be able to sustain some forms of vegetation. Some forms of life might exist in underground cavities.

The author presents his conclusions and suggestions tentatively. Some or all of them may be wrong, but he regards them as consistent with the observational data and the known laws of physics.

The book also contains purely descriptive matter and a digest of observations and other lunar data-temperatures, variable markings, colors, etc. The appendix deals extensively with the theory of dissipation of planetary atmospheres, atmospheric structure, and problems of evaporation.--Auth.

3-1013. Arctic Institute of North America. ARCTIC BIBLIOGRAPHY, VOL. IX. Edited by Marie Tremaine: 1599 p., map, Washington, D.C., U.S. Dept. of Defense, 1960.

Continuation of this annotated bibliography of scientific literature on the arctic and subarctic regions of the world. This volume contains 7,192 references, mainly to material published during 1957-1958, including publications on geology and related sciences.

3-1014. STATE GEOLOGISTS JOURNAL, v. 12, no. 2, 35 p., Oct. 1960.

A general description of this journal was given in GeoScience Abstracts 2-3132. In this issue news and recent activities are recorded from 13 states; 84 state survey geologists whose biographies appeared in the Dictionary of American Biography (1928-1936) are listed; a bibliography of biographical articles appearing in this journal is given; and the minutes of the 52nd annual meeting of the Association of American State Geologists is recorded. Two papers from this issue are separately abstracted below.--M. Russell.

3-1015. Hastings, Earl L. THE MAKING OF A STATE SURVEY GEOLOGIST: State Geologists Jour. v. 12, no. 2, p. 17-18, Oct. 1960.

In order to serve a state's citizens by helping them understand, utilize, and conserve their rocks, minerals, and waters, and to serve the science of geology by conducting and reporting on basic and applied research, the following qualifications, in addition to being a well-trained geologist, are necessary to make a state survey geologist: 1) enthusiasm to tell others about the geology of his state; 2) ability to meet all sorts of people; 3) desire to do general field work; and 4) ability to write and speak on the layman's level.--M. Russell.

3-1016. Laird, Wilson M. WHAT SHOULD THE STATE GEOLOGICAL SURVEY BE DOING? State Geologists Jour., v. 12, no. 2, p. 19-22, Oct. 1960.

A state geological survey has the following fundamental duties: 1) the gathering of basic geological data, i.e., basic research in geological materials; 2) studies of certain commodities indigenous to the state; 3) maintenance of an information service to state citizens and others interested; 4) storage of basic geological data; and 5) regulation of certain resources depending upon the law of the state concerned.--From introd.

3-1017. Jamaica, Geological Survey Dept. ANNUAL REPORT... FOR THE FINANCIAL YEAR 1958-1959: 25 p., graph, tables, Kingston, 1960.

3-1018. Salas, Guillermo P. PROGRAMA Y RESULTADOS DE TRABAJOS REALIZADOS DURANTE EL AÑO DE 1959 [Program and Results of Work Performed During the Year 1959]: Mexico, Universidad Nacional, Instituto de Geologia, Anales, v. 16, 17 p., map, 1960. Text in Spanish.

A summary of work done by the Institute in general geology of the following regions: Chilpancingo and Acapulco, Zacualpan, Sultepec, Balsas basin, Toluca valley, Mexico basin; also economic geology in Chihuahua, Sonora, Guanajuatos; exploration for bauxite; mineralogy-petrology; marine geology; macro- and micropaleontology.

3-1019. Baker, Wilfred H. ELEMENTS OF PHOTOGRAMMETRY: 199 p., illus., maps, diags., table, New York, Ronald Press 1960, refs.

The elements of photogrammetry are presented, with particular emphasis on the physical and mathematical principles involved. Photogrammetry is followed logically through the successive stages of planning an aerial survey, the flight, the production of photographs, ground control, and the use of the photographs, beginning with the simpler devices and progressing to the more complex stereoplotting equipment.

Fundamental principles have been emphasized, especially with respect to the vertical photograph and the theory and use of the stereoscope. Varied numerical problems are provided, which are suitable either as home assignments or as supplements to the laboratory work.--From pref.

Contents: aerial photography; photographs, indexes, and mosaics; interpretation and control; vertical photographs, radial-line mapping; stereoscopic principles; tilt analysis; precise determination of tilt; tilted photographs; stereoscopic plotting instruments; oblique and terrestrial photographs; applications.

3-1020. Marsh, Owen T. A RAPID AND ACCURATE CONTOUR INTERPOLATOR: Econ. Geology,

v. 55, no. 7, p. 1555-1560, illus., 2 diags., Nov. 1960.

An instrument called a "contourpolator" is described. The device is constructed from readily available materials costing about $2.00 and consists of 4 primary parts. Detailed instructions are provided for its assembly and use.--J. A. Chamberlain.

3-1021. Mills, Joseph W. CONSTRUCTION AND USE OF AN INEXPENSIVE CONTROLLED PHOTOMOSAIC FOR GEOLOGIC MAPPING: Jour. Geol. Education, v. 8, no. 2, p. 58-62, Fall 1960, 3 refs.

A method is described for constructing an inexpensive controlled photomosaic of an area having vertical aerial photographic coverage. The mosaic is used as a base map for geologic mapping where an adequate planimetric map is lacking. Distortions in the aerial photographs are reduced or eliminated by projecting the images of points on the photographs so that they coincide with corresponding points on a control sheet mounted on a tilting easel. The control sheet is prepared by photo triangulation, with or without additional ground survey control. The corrected image is reproduced on photographic paper and the prints combined to make a controlled photomosaic. Geologic data recorded on aerial photographs can be transferred easily and quickly to the mosaic and thence to a transparent overlay sheet for reproduction.--Auth.

3-1022. Mozola, Andrew J., comp. U.S. PUBLIC LAND SURVEY GRID: Am. Geol. Inst., AGI Data Sheet 22, 2 p. in GeoTimes, v. 5, no. 5, p. 29-30, Jan.-Feb. 1961.; also pub. separately.

The specifications of the U.S. Public Land Survey Grid are presented for reference. Townships are numbered N. and S. of a base line, and E. and W. of the principal meridian. Each township is a 6-mi. square that is further subdivided into 36 one mile squares called sections. The sections are numbered consecutively from right to left and left to right.--M. Russell.

3-1023. Mears, Brainerd, Jr. STUDENT TRAINING FOR A SUMMER FIELD COURSE: Jour. Geol. Education, v. 8, no. 2, p. 44-48, Fall 1960.

Poor performance by potentially capable students during a summer field course in geologic mapping usually results from inadequate background in basic geology. Proper training to prepare for mapping should instill facts and principles, the use of 3-dimensional visualization, and an acquaintance with the scientific method. Initial weakness in fundamentals lessens a student's accomplishments in structural interpretation, a primary objective of a mapping course. In light of this, some geology teachers would do well to reappraise their major program.--Auth.

3-1024. Rahm, David A. AN INTEGRATED FINAL EXAMINATION FOR LABORATORIES IN INTRODUCTORY GEOLOGY: Jour. Geol. Education, v. 8, no. 2, p. 49-53, 2 maps, Fall 1960, ref.

A huge geologic map is drawn on the floor of the laboratory or on a suitable surface outdoors. Specimens of rocks, minerals, and fossils representative of the geologic formations depicted are placed between contacts. Students, walking on the field area, "do" the geology by reproducing the outcrop pattern at an appropriate scale and labeling their maps according to rock, mineral, and fossil identifications. Geologic sections are then prepared from the completed map and a geologic history (in terse, outline form) is given. The interdependence of all phases of laboratory work is shown very realistically in this way.--Auth.

3-1025. Higgins, Charles G. MINERALS FOR THE PHYSICAL GEOLOGY LABORATORY: Jour. Geol. Education, v. 8, no. 2, p. 41-43, Fall 1960, 15 refs.

A list showing the frequency of citation of mineral species among 15 introductory geology textbooks and laboratory manuals is helpful in evaluating species used in the introductory course. Species low on this list should be selected only if they serve a definite purpose in the educational objectives of the course. --Auth.

3-1026. Brown, Walter C. CLASSROOM STREAM TABLE: Jour. Geol. Education, v. 8, no. 2, p. 63-64, diag., Fall 1960.

A stream table can be used to show in miniature a wide variety of natural processes. The making of a simple but effective stream table, from readily available materials, is described.--Auth.

3-1027. Summerson, C.H. NEW MAPS FOR TEACHING TOPOGRAPHIC-MAP INTERPRETATION: Jour. Geol. Education, v. 8, no. 2, p. 54-57, Fall 1960, 5 refs.

As the uses of topographic-map interpretation become more widespread, not only in geology but in such new fields as "terrain science," a re-examination may well be made of teaching objectives, methods, and materials. Several levels of instruction are involved: recognition of individual landforms, understanding of landscape associations, and techniques of quantitative expression and analysis. The rapidly increasing number of topographic maps makes desirable the compilation of carefully selected up-to-date lists to supplement the familiar lists in standard texts on map interpretation. This is too great a task for an individual teacher, but it could be done by cooperative effort under sponsorship of the National Association of Geology Teachers.--Auth.

3-1028. Eckel, Edwin B. OPPORTUNITIES AND RESPONSIBILITIES OF EARTH SCIENTISTS IN THE NUCLEAR AGE: U.S. Geol. Survey, Circ. 430, 8 p., 1960.

All releases of nuclear energy pose problems for geologists, for they must supply geologic facts that bear on safety, efficiency, or economy. Production of power, directly or indirectly from nuclear reactions involves similar duties. There are also many opportunities for fundamental research in the earth sciences. Most of these involve the effects on rocks of extremely high temperatures, and of shock waves whose origin and timing are known. A partial bibliography is included.--U.S. Geol. Survey.

3-1029. Snelgrove, A.K. OPPORTUNITIES IN GEOLOGY AND GEOLOGICAL ENGINEERING: 86 p., 4 tables, New York, Vocational Guidance Manuals, 1960, 45 refs.

This career book is designed to provide the reader with occupational information to aid in the search for the right career. Chapters cover: scope of geology, geological engineering, and earth sciences; educational preparation; getting started; what geologists do; related fields; and geological societies. Appendices list career booklets dealing with the earth sciences and colleges and universities offering undergraduate and graduate degrees in earth sciences.

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